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Kohei Okamoto
Yoshitaka Ishikawa
Editors

Traditional Wisdom and Modern Knowledge for the Earth's Future

Lectures Given at the Plenary Sessions of the International Geographical Union Kyoto Regional Conference, 2013

Springer

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AJG Library 1

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Editors
Kohei Okamoto
Department of Geography
Nagoya University
Nagoya, Japan

Yoshitaka Ishikawa
Department of Geography
Kyoto University
Kyoto, Japan

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Preface

This compilation of academic works has been prepared as a companion to the International Geographical Union (IGU) Kyoto Regional Conference (KRC), held at the International Conference Center (ICC Kyoto) August 4–9, 2013. Its nine papers correspond to the nine keynote speeches given in the plenary sessions of the conference. Here, we would like to briefly explain the background of this book.

In December 2006, accepting a proposition by Professor Hiroshi Tanabe, a Vice-President of IGU at that time, the National Committee of Japan for IGU began to prepare its bid as a candidate venue of IGU's Regional Conference. Consequently, the Invitation Committee was established in spring 2007, and a critical task for the committee was to prepare the Proposal, which had to be submitted to the IGU Secretariat by the end of that year. Particularly important was the conference theme, which needed to be specified in the proposal.

Kyoto was selected as the conference city very soon into the planning. However, none of the area's universities had a geography department with a large faculty and staff, and thus the ICC Kyoto was chosen as the event's venue. The question of a possible theme was vigorously discussed by the Invitation Committee members in fall 2007. The ICC Kyoto was still well known as the birthplace of the Kyoto Protocol, and in this spirit "Traditional Wisdom and Modern Knowledge for the Earth's Future" was finally selected as the conference theme. The rationale of this decision can be understood as follows.

Over the past few decades, globalization and other remarkable changes have restructured the relations between countries and regions of the world, in the process greatly altering the world's geographies. These changes have led to various problems on the local, national, and global scale, such as economic imbalances, social fragmentation, political conflicts, and environmental crises. Some have expressed the fear that these problems even threaten the future of the earth. While acknowledging the world's diversity, geography as a discipline must endeavor to help resolve these problems by devising strategies for cooperation and symbiotic co-existence of the different peoples of the world.

There is an old Japanese proverb温故知新(*on-ko chi-shin*), which was taken from the words by Confucius, an ancient Chinese philosopher. 温故(*on-ko*) means "cherishing the old" and 知新(*chi-shin*),"understanding the new." *On-ko chi-shin* has been interpreted as "Only by exploring the old can one understand the new" or "Reviewing the past helps one to gain new insights." The theme of our conference, "Traditional Wisdom and Modern Knowledge for the Earth's Future," is based on this East Asian philosophy. We should first understand how traditional ideas on the interaction between society/culture and the environment were formed in different countries and regions. Traditional wisdom, in harmony with the environment, remains prevalent. The Regional Conference held in Kyoto, Japan, will examine how we can mold the earth's future through such traditional wisdom as well as advanced knowledge derived from modern geography.

The ICC Kyoto hosted the 1997 United Nations Framework Convention on Climate Change, which gave birth to the famous Kyoto Protocol. Although the Protocol focused on the prevention of global warming, KRC aimed for a comprehensive examination of various problems in the relationship between society/culture and the environment as well as comprehensive discussions about the earth's future. Kyoto is furthermore the ancient capital of Japan, a metropolis with a long history and one that is richly endowed with a wide variety of fascinating sites from the standpoint of "traditional wisdom."

Our success in inviting the regional conference to Kyoto in 2008 was followed by a terrible disaster, namely, the Great East Japan Earthquake/Tsunami of March 11, 2011. That natural catastrophe led to even further extensive damage with the resulting breakdown of Tokyo Electric Company's Fukushima Daiichi Nuclear Power Plant. As of the beginning of August 2013 when KRC was held, over 15,883 people are confirmed dead and 2,656 remain unaccounted for. More than 300,000 persons were displaced. This great tragedy was also investigated in relation to our conference theme.

The KRC's Organizing Committee, whose chair is Yoshitaka Ishikawa, the second editor of this book, held plenary sessions related to this theme. As the entire theme "Traditional Wisdom and Modern Knowledge for the Earth's Future" is somewhat broad, the committee came up with three subthemes: traditional wisdom, the environment, and the Great East Japan Earthquake. Each of the three scheduled sessions consisted of three plenary lectures for each subtheme. Outstanding speakers were selected in fall 2011, mainly by the Scientific Program and Publication Committee, whose chair is Kohei Okamoto, the first editor of this book. The book's title and its structure reflect the background described here.

We hope many people will become interested in the important topic "Traditional Wisdom and Modern Knowledge for the Earth's Future" through reading the contributions presented in this book.

Nagoya, Japan — Kohei Okamoto
Kyoto, Japan — Yoshitaka Ishikawa

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Why There Were Not Originally in the Japanese Language Equivalents to the Words 'Environment' and 'Nature'

Minoru Senda

Abstract Until the nineteenth century the Japanese had no words equivalent to what in European languages would correspond to "environment" and "nature". Japanese felt bodily united with "nature", i.e. did not perceive the latter as a separate existence. Therefore, "environment" in the sense of "something which surrounds the human body" was for the Japanese something inconceivable. When a Japanese uses the word "environment" in an European language, he or she is conscious of a "nature" which surrounds the humans, which is subordinate to humans, and in regard of which humans are placed in an haughty position. And only when humans cease being haughty in respect of any single aspect of nature, only then "the environmental problem" in *the European sense* will advance in the direction of resolving.

Keywords Animism • Kami • Kiso river • The idea of 'jô • Tobusa

1 Animism and the Japanese View of Nature

Many authors contrast the 'stone' culture of Europe with the 'wood' culture of Japan. Here, I discuss the traditional Japanese view of nature, especially of trees and mountains from the religious standpoint of animism. Animism believes that a spirit abodes in everything, in both organic and inorganic matter.

In his work Primitive Culture (1871), the nineteenth century British anthropologist E. B. Tylor defined animism as the most primitive of religions. Tylor looks down at animism from the standpoint of the complex religious system of Christianity.

M. Senda (✉)
Nara Prefectural Library and Information Center, 1-1000 Daianji-nishi, Nara City, Nara 630-8135, Japan

The International Research Center for Japanese Studies, Kyoto, Japan
e-mail: senda@library.pref.nara.jp

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Fig. 1 Keiji Iwata (1922–2013). ©Yoshihiro Tatsuki

Given modern worldwide discussion of 'environmental problems', I suggest the animistic point of view may give a better perspective.

Keiji Iwata (1970) (Fig. 1) explains Japanese animism in the following way. Throughout history, humans have worshipped *kami* (divinities) and treated *kami* with high respect. Mountains and rivers, herbs and trees, insects, and fish have all revealed themselves as *kami*, and humans have always looked for a certain kind of encounter with these *kami*. Iwata believed that this primitive feeling about nature opens a window to reach out to the universe. Iwata's ingenious cultural theory on the origins of *kami* echoes in modern discussions about animism.

Although Shintô and Japanese Buddhism appear reluctant to be compared with animism, Takeshi Umehara (1989) points that both are deeply tinted by animistic beliefs Umehara reasons that human attempts to rule nature leads to its destruction, and the time has come when humans should reconsider the base of their haughtiness. As part of this reconsideration, we need to re-evaluate animism as an important way of thinking. Another scholar, Yoshinori Yasuda (2006), thinks the respectful attitude to the living worlds of forests and seas is an indispensable part of the solution of modern environmental problems. Yasuda's and Umehara's opinions are largely inspired by the traditional Japanese views of nature.

My point of view is close to Iwata's, and I think that his latest work Iwata (2005) precisely reveals the essence of animism.

1.1 What are the Core Beliefs of Animism?

Animism believes that a *kami* inhabits every tree, stone, insect, and bird, and respects the full of *kami* nature. In this way, every tree, each mountain, and every single person becomes a hero or a heroine of the universe. Each of us is a part of that universe, and the landscape breathes with life. This is the core of animism.

This chapter aims to describe the essence of animism and the place of man in its sphere. The chapter will argue that this view implies that 'man' does not exist at the center of nature surrounded by a separate 'environment'. It is impossible to discuss animism or to develop environmental theory without paying enough attention to this point.

1.2 "Environment" and "Nature"

No ancient Japanese words correspond to the English words 'environment' and 'nature'. The words '*kankyô*' (environment) and '*shizen*' (nature) were first used in Japan under the influence of European languages, from the second half of the nineteenth century. For several reasons, Japanese did not use these words until then.

The word 'environment' in European languages implies 'nature' surrounding humans and thus places humans at the center. This implied attitude divides nature and man. In contrast, the lack of words for environment and nature in Japan implies that no such division exists. Iwata argues that the Japanese considered man as just another element of 'nature'.

In the Preface of his lecture titled *Japan, the Beautiful and Myself*, delivered when receiving the Nobel Prize for Literature, Yasunari Kawabata (1969) (Fig. 2) refers to the 'Japanese view on nature' by citing the following poem by Myôe (Fig. 3).

> I shall go behind the mountain. Go there too, O moon.
> Night after night we shall keep each other company.

Kawabata's comments on this poem stress the union with nature, the absorption within it by looking at the moon with intimacy, instead of as just a companion. In reality, it is impossible for man to be united with 'nature'—the line between them seems too thin or, to put it better, there is almost no sense of distance between the two.

A Buddhist monk like Myôe dwells in a sacred realm and can find peace in making 'nature', in the face of the moon, his companion. Yet, for people living in the secular world, 'nature' is at the same time companion and an existence which surpasses it—it is *kami* (but not God).

This difference can be explained by paddy field farming. Water is crucial to rice cultivation, the main cereal in Japan. However, a single household cannot manage the water supply alone and ancient farming villages developed a water supply system, which included all the households in the village. Water is not only a friend of

Fig. 2 Yasunari Kawabata (1899–1972). *Source*: Ibaraki Municipal Kawabata Literature Memorial Hall

paddy field cultivation, it is an indispensable existence. The farmers could not supply water of their free will—water supply was subordinate to the climate—and farmers considered that it was controlled by the will of *kami*. Thus, water as part of 'nature' became a *kami* itself. Villagers dedicated a shrine at the watershed, called *Mikumari* (Figs. 4 and 5), to the *kami* who distributed water. The village community maintained the supply of water, the main constituent of the paddy field cultivation, by *kami* worship, and was thus united with water as part of 'nature'.

1.3 Nature and Kami

We can say that the word 'nature' in Japanese has qualities that made it replaceable by the word *kami*. Let us go back to the world of literature and consider the following words of the famous Japanese haiku poet, Bashô.

> Saigyô'swaka, Sôgi'srenga, Sesshû's painting, Rikyû's tea ceremony—one thread runs through the artistic Ways. And this aesthetic spirit is to follow the Creative, to be companion of the turning of the four seasons. Nothing one sees is not a flower, nothing one imagines is not the moon. If what is seen is not a flower, one is like a barbarian, if what is imagined is not a flower, one is like a beast. Depart from the barbarian, break away from the beast, follow the Creative, return to the Creative. (from *Bashô's journey: the literary prose of Matsuo Bashô* by David Landis Barnhill).

Here, the word "creative" refers to *kami* as creator of all things, yet Bashô's words mean that the thought of historically celebrated personages, such as the poets

Fig. 3 Myoe (1173–1232). *Source*: Kyoto National Museum (deposited by Kosanji Temple)

Fig. 4 Tsuge Mikumari Shrine in Nara Prefecture. *Source*: TsugeMikumari Shrine

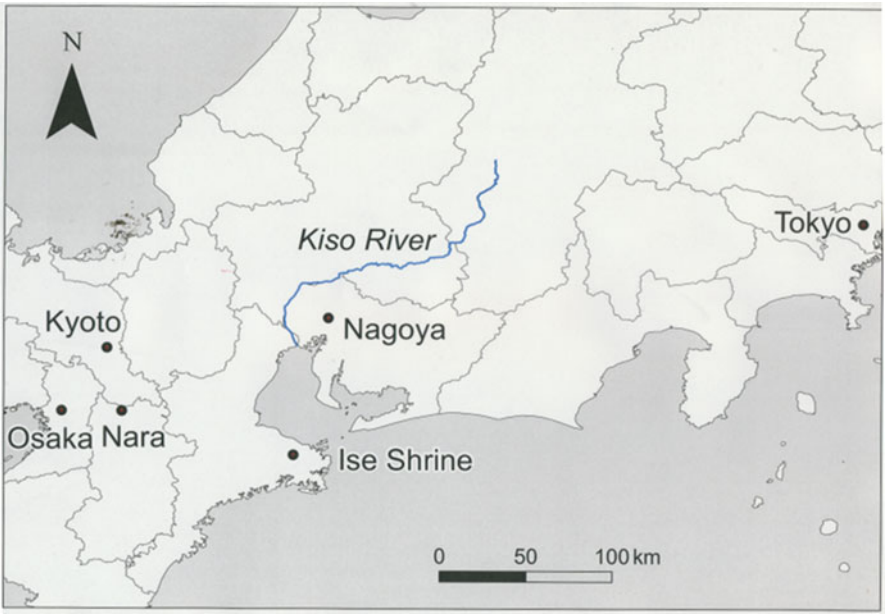

Fig. 5 Map related to this article

Saigyô and Sôgi, the painter Sesshû, and the tea master Rikyû follow Creation and return to Creation. Their works walk hand in hand with the seasons, revering the viewing of the tree blossoms and the contemplation of the moon. In this way, "Nature" with its four seasons, is referred to as a companion, in the same way as Myôe spoke of the moon. A companion is a "mate" or a "fellow traveler" and in this sense, artists regarded "nature" as a "companion" and no clear line could be drawn between them. It was a part of Japanese classics that men of art saw *kami* in 'nature'.

The difference between the Japanese and the Christian views on nature is shown in this hymn.

O mighty God, when I behold the wonder
Of nature's beauty, wrought by words of thine,
And how thou leadest all from realms up yonder,
Sustaining earthly life with love benign,

Refrain:

With rapture filled, my soul thy name would laud,
O mighty God! O mighty God! (repeat)
When I behold the heavens in their vastness,
Where golden ships in azure issue forth,
Where sun and moon keep watch upon the fastness
Of changing seasons and of time on earth.

When crushed by guilt of sin before thee kneeling,
I plead for mercy and for grace and peace,

Fig. 6 Torahiko Terada (1875–1935). *Source*: Kochi Literary Museum

> I feel thy balm and, all my bruises healing,
> My soul is filled, my heart is set at ease.
>
> And when at last the mists of time have vanished
> And I in truth my faith confirmed shall see,
> Upon the shores where earthly ills are banished
> I'll enter Lord, to dwell in peace with thee.
> ('How Great Thou Art', Hymn 161–2, based on the poem of Carl Boberg; the above English translation is from the 1973 edition of *The Covenant Hymnbook*)

Although this hymn also sings about the relation between God and nature, the view of nature differs from that of Myôe. The hymn creates an image of God in the middle and nature hanging around him, that is, an apprehension of the universe with God in its center.

In contrast, the physicist Torahiko Terada (1948) (Fig. 6) wrote about the Japanese view on nature in the following way.

> Another marked feature of Japan is the garden attached to a house, and this is often given as a fine example for the explanation of the characteristics of the Japanese view on nature. While many Westerners feel joy in shaping nature into designed forms and creating geometrical gardens, the Japanese enjoy the feeling of dipping into nature, of unification with nature, by inviting nature close to themselves at their places, taking care to spoil its natural looks as little as possible. Even in front of a small store of the back streets, a pot with morning glories can be seen. Watching this, I often think that the Japanese will never become completely westernized, that Western thought and isms cannot take root into Japanese soil as they are.

Fig. 7 Norinaga Motoori (1730–1801). *Source*: Museum of Motoori Norinaga

The fact that the landscape which Terada describes as "even in front of a small store of the back streets, a pot with morning glories can be seen" is disappearing from modern Japan may indicate that the Japanese are losing their traditional appreciation of nature.

1.4 The Japanese Sense of Beauty Often Relates to the Changing of Seasons

Hideo Kobayashi (1974) points that the Edo period scholar of Japanese literature, Norinaga Motoori (Fig. 7) deeply loved *sakura* (the cherry tree blossoms) and asked that a *sakura* tree be planted on his grave (Fig. 8). He also drew pictures of cherry blossoms and wrote the following well-known poem:

> If they ask me about the pure heart of Yamato –
> The odor of cherry blossoms in the morning sun
> Would say I.

1.5 Putting up of a **Tobusa**

In this section, I discuss the traditional wisdom of the Japanese about nature viewed as full of *kami*. The most explicit symbol of this view is the putting up of a *tobusa*,

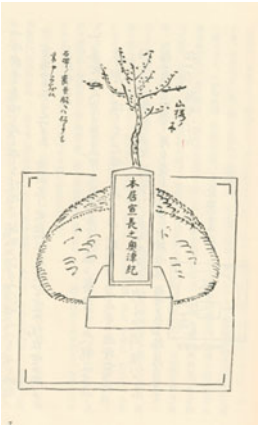

Fig. 8 The Norinaga Motoori's grave by his testament. *Source*: Museum of Motoori Norinaga

though this custom is no more in practice. We find the following song in *Manyôshû*, the earliest poetical anthology in Japan (eighth century).

I have gone to cut wood,
Cut down ship-timber
In the Ashigara mountain
(Minding of the bundle of branches
offered on the tree stumps to the god of the tree-tops),
but alas, that ship-timber!
(was already cut down and taken away by others).
(*Manyôshû* vol. III, poem 391)

The bundle of branches spoken of here is a *tobusa,* which represented the top of the cut tree or a bundle of branches bearing leaves, placed on the stump in dedication to the *kami* (divinity) of mountains.

The above poem means: You put up a *tobusa*when you cut a tree for a boat at the mountain Ashigara, when you choose and cut a good tree to take away with you. Oh, what a pity!

Another poem in the same anthology also mentions *tobusa*.

The mountain island of Noto, where ship-timber is said to be cut down,
(Minding of the bundle of branches
offered on the tree stumps to the god of the tree-tops),
When I look at it today, the woods are dense.
How many years it must have stood there
To get that attitude of a god!
(Manyôshû vol. XII, poem 4,026)
(The translation of both poems is from 1,000 poems from the Manyôshû: The complete Nippon Gakujutsu Shinkokai translation, Mineola, N.Y., 2005)

The meaning of the poem is as follows: The Peninsula of Noto, where people cut trees to make boats and place *tobusa*, seems overgrown with trees. It is because of its divinity for many generations.

As we understand, especially from the second verse, the abundance of the trees despite repeated felling is because people had put up *tobusa* so that the woods

become divine. The *tobusa*is a prayer to the *kami* of mountains to give life to new trees after the felling. Thus, we can say that the act of *tobusa* reflects the religious ethic to avoid disorderly cutting and influences the behavior of forest workers.

Before becoming a contemporary-style poet, Toshio Mae (2003) sang of *tobusa* in nostalgia for the ancient tree worship.

> The sun solemnly brightens
> The moment when the tops of the cedars will be cut down
> Oh, forefathers! You who put up *tobusa* –
> The sign of a king
> On the stump of the cut tree!

2 The Rebuilding (*sengû*) of the Great Shrine of Ise and Purity

The religious view of trees described above is also expressed in one of the ancient prayer, *norito*, recited on the occasion of the Big Palace Festival *Ô-tono-hokahi*. The last is a religious ritual accomplished to secure peace at the imperial palace. Here is a short part of this *norito*-prayer:

> For the palace of our Emperor, for the trees that grow deep in the mountains –
> Take the workman's immaculate axe, which purifies contamination,
> And cut a tree.
> Then offer this tree's top and this tree's bottom to the *Kami* of mountains,
> And take this tree's trunk, and shape it with an immaculate spade,
> And put up an immaculate pillar…

This abstract demonstrates how the timber for the construction of the palace had to be purified by *kami*. In this way, the palace, made of purified wood, was also regarded as a pure space.

The Shrine of Ise (Figs. 9 and 5) is dedicated to the ancestress of the imperial family and stands in the center of Japanese *Shintô* beliefs (the traditional religion of Japan worshipping *kami*). The shrine is rebuilt every 20 years following a ritual called *Sengû* ('transferring of the Shrine'). The Shrine will be rebuilt for the 62nd time in the autumn of 2013. The main reason for this rebuilding is to maintain purity of the Shrine and its grounds.

Each rebuilding needs more than ten thousand hinoki (Japanese cypress trees, and most should be about 300 years old. Until somewhere between the twelfth and the fourteenth centuries, all these trees were cut from the mountain of the Shrine. With time, however, fewer timber trees of sufficiently good quality were available, and from the fifteenth century on timber for the Shrine rebuilding was supplied from different regions. Before WWII, whole mountains in Nagano and Gifu prefectures were dedicated to the provision of the necessary timber. These mountains were called the Birin (wood reserve) of the Shrine. Yet, their resources have also diminished, and a recent plan was developed for the supply of wood from the forest around the Shrine (Fig. 10). This plan calls for replanting sufficient number of trees

Fig. 9 Ise Shrine. ©*Jingu Shicho*

Fig. 10 Mountains around Ise Shrine. *Source*: Geospatial Information Authority of Japan

to supply rebuilding timber for the next 200 years. The intention is to stop robbing nature of wood and replace felled trees, thus maintaining nature's wheel of life. Kenichi Yano (1992) says that the reason Japan possesses as much as 25,000,000 Ha (70 % of its mainland) of forests lies exactly in its paying attention to this nature's wheel of life.

3 Pictures of Rituals Related with Forestry

In the second half of the nineteenth century, the artist Ayahiko Tomita drew a series of pictures showing woodcutting at mountain Kiso (modern south-western Nagano Prefecture) and its raft transportation along the Kisoriver to Kawaguchibe in Owari (modern Aichi Prefecture). The title of this remarkable work is *Kiso-shiki-batsubokuunzaiZue* (Figs. 5 and 11). According to the bibliography on this work by Mitsuo Tokoro (1975), I would like to show you the pictures that are related to the present topic.

3.1 Worshipping of the Kami *of Mountains*

As soon as the workmen's forest hut is constructed, a ritual dedicated to the *kami* of mountains is carried out. A *sakaki* tree (an evergreen tree with broad leaves) and *gohei* (cloth, later silk or paper, offered to *kami*) are attached to the roots of a very old tree. A straw rope called a *shimenawa*, is placed around the tree to mark the sacred ground, and the *Kami* of Mountains is worshipped. The *kami* is offered sacred sake (*miki*) and a prayer for the safety of the work. This ritual is not a simple formality for the forest workers, who dread injuries caused by accidents or natural calamities (Fig. 12).

3.2 The First Cut

This picture shows an old custom. Before the workers cut at the trunk close to the roots, they knock on it with an axe. If squirrels or birds run away from among the branches, they do not cut that tree the same day (Fig. 13).

Fig. 11 *Kiso-shiki-batsubokuunzaizue* (The picture book on wood felling and transportation of Kiso system)

Fig. 12 The picture of worshipping for the *Kami* of mountains. *Source*: *Kiso-shiki-batsubokuunzaizue*

Fig. 13 The picture of first cut. *Source*: *Kiso-shiki-batsubokuunzaizue*

3.3 Worshipping of the Stump

After a tree has been cut, gratitude is offered to the *Kami* of Mountains by placing the top of the cut tree on its stump. I have previously described this as *tobusa* (Fig. 14).

Fig. 14 The picture of worshipping of the stump (*tobusa*). *Source*: *Kiso-shiki-batsubokuunzaizue*

Fig. 15 The picture of offering of timber to the Great Shrine Ise. *Source*: *Kiso-shiki-batsubokuunzaizue*

3.4 Offering of Timber to the Great Shrine of Ise

The workers offer their first-cut tree to the Ise Shrine (Fig. 15).

3.5 Carrying Around of Ise Shrine's o-fuda

Attaching Ise Shrine amulets (*o-fuda*) to the branches of green bamboo and carrying them around is a prayer to secure safe river transportation of the timber (Fig. 16).

Fig. 16 The picture of carrying around of Ise Shrine's *ofuda. Source*: *Kiso-shiki-batsubokuunzaizue*

As we can see, the relation with *kami* is very close during the whole process, from the felling of wood to its transportation by river rafts.

4 Tree Worship and the Protection of Ancient Trees

A tree is a *kami*. This is clearly shown, even today, by the 'heart pillar' (*shin-no-mihashira*) of the Great Shrine of Ise, the place of worship of the sun goddess Amaterasu. As I wrote above, the shrine is ritually rebuilt every 20 years. Before the new structure is erected, a plate of precious stone with a small wooden structure in the center is placed in the shrine grounds (Fig. 17). This structure houses the heart pillar, which stays in the very center of the shrine, right beneath the mirror dedicated to the goddess and considered her symbol (*shintai*). The heart pillar is so low it does not protrude from the floor and is surrounded by *sakaki* (sacred evergreen shrub *Cleyera japonica)* branches. It is believed to be the most sacred part of the Shrine.

What was the original meaning of this pillar? A strong hypothesis is that it symbolizes a *himorogi,* which is the seat of *kami* within the sacred space. As mentioned, it is surrounded by evergreen branches and probably bears features of the time when it was considered the representative of the *kami*. In Japanese, different suffixes are used to count different objects, and the suffix for counting *kami* is *kashira*, which also means pillar. Thus we might conclude that the pillar was the original symbol of the *kami* of Ise. The Japanese creation myth also tells how the progenitors of the world, Izanagi and Izanami, started their relation by going around the Sacred Heavenly Pillar.

Belief that *kami* abode in trees or wooden pillars was the original form of religious worship in Japan. The word for the place where *kami* are worshipped was *mori*. In archaic Japanese, *mori* can be written in two different ways: with the Chinese

Fig. 17 Herat pillar in Ise Shrine. ©*JinguShicho*

character for 'shrine' and with that for 'forest'. The Iwanami Edition dictionary of archaic words defines *mori* as "a sacred space, a shrine etc., overgrown with trees… a place where *kami* descends" This definition indicates the same etymology as the Korean word '*mori*' (mountain). In the same dictionary, we find '*mimoro*', where '*mi*' is a prefix and '*moro*' has the same origin as *mori* (written with the Chinese character for 'shrine'), that is, "a place where a *kami* descends". According to this interpretation, the other name of Mount Miwa in Yamato—Mimoro—(Fig. 18) indicates a mountain where *kami* come down. This evidence suggests that *moro*in the word *himorogi*, the object inhabited by a spirit, has the same meaning.

Shôei Mishina (1972) also found that the word *moro* was used in other cultures. In the homes on the Korean peninsula, the place of the new grains' container is called *maru* and is considered sacred. Among the Tunguspeople from Eastern Siberia, a place in the house (tent) where divinities are worshipped is called *maru* or *maro*; this is also where the oldest member of the family or an honorable guest is seated. The Japanese word *moro* belongs to the same word group. Fusanoshin Ayukai (1971) suggested that the words *maru* or *maro* used in the names of aristocrats, or as euphemism for boys, as well as for ships and swords, has the same origin.

Thus, Mishina interprets *moro* as a sacred object or place that originated in North Asia. However, Mishina does not emphasize the relation of *maru* or *maro* with trees, although he points out that *moro* and also *mori* describe sacred places where *kami* descend. This implies the word *mori* became associated with trees because of the sacred character of trees. Combined with other words, *mori* does not mean just a place overgrown with trees but a place that has become sacred because of the trees growing there.

Fig. 18 Mt. Miwa yama

The recognition of the sacred character of trees encourages tree protection. Kanichi Nomoto (2006) collected data on views of tree protection. He concluded that the taboos that prevent entry to a mountain during days when its *kami* is worshipped, spread from the North of Japan (Tôhoku) south to Kyûshû, have two important elements. One is the supervision the trees, the other is the supervision of animals and birds belonging to that *kami*, because the *Kami* of the mountain is the mother who gives birth to trees, animals and birds all together. The *Kami* counts the trees one by one, exercises control over the felling and supervises growth. The tradition of taboo on entering the mountain is a sign of respect by the humans for her life-giving deed.

In Kawakami (Hamamatsu, Shizuoka Prefecture), the pointed part of the stump of the cut tree was called *yarikuchi*. Foresters believed that if a bird caught an insect on it, the person who had cut the tree would fall sick. This taught young workmen to cut trees neatly. The forester fallen sick in the above conditions could be cured by placing the above mentioned *gohei* (or planting *sakaki* or evergreen oak branches around the stump if the tree had been very big) and praying. This tradition may have arisen to prevent passers-by from hurting themselves on the point of a stump, but may also have considered a badly cut tree harmed the tree spirit (*kami*), which would not be able to find peace and could grow violent.

It is certain that both the fear and the modest attitude of the people working in the mountains underwrite principles concerning nature.

Many Japanese shrines are located in woods, and people cannot freely cut trees because the trees belong to the *kami* worshipped in the shrine. Many shrines still exist, and it is worth noting that these beliefs help conserve vegetation. An excellent example is the sacred mountain Kasuga, which belongs to the Kasuga Shrine in the city of Nara (Fig. 19). A law prohibiting tree felling was promulgated in about the ninth century, and the vegetation of Kasuga (dominated by subtropical broad-leaf trees) is unchanged to the present day.

Fig. 19 Mt. Kasugayama. *Source*: Geospatial Information Authority of Japan

5 The Idea of '*jô*' (Religious Purity of Heart)

I wrote above about the relation between sacred space and purity, and that sacred space includes purified woods. Let me now consider the opposite of purity: 'pollution'. 'Uncleanness' endangers living organisms, and perhaps the reason Japan is late showing concern about the pollution of nature lies in the concept of cleansing (*misogi*). This idea is deeply rooted in Japanese culture. The *Purification Norito* prayer, chanted on the last days of the sixth and the twelfth months, finishes

> The Urabe of the Four Countries, take away [the uncleanness] by way of the large rivers, take it away with you. Go away, pollution!

These words refer to the cleansing of the evil from the human body. The custom was to blow one's breath into dolls on the riverbank and then float the doll down the river away to the sea, thus removing evil. In this context, the idea of bodily purification, the antagonism between man and the surrounding natural environment is quite thin. The shore and river are regarded as corporal organs that were believed to cleanse the human being, to discharge evil from the body. Thus, the 'purified', immaculate '*jô*' (cleanness) is the 'condition' for the merging of the human spirit

and nature (water). It does not concern only man or only nature, but belongs to what can be called the chaotic world of senses. In this spiritual context, the Western idea of an 'environmental problem' is hard to accept.

The concept of '*jô*' or '*seijô*' (written with two Chinese characters with the approximately same meaning) is related with the removing of 'dirt' or *kegare* ('contamination') and in everyday life is achieved by its absolute opposition, the '*hare*' (holiday). That is why the place of the religious ritual was '*jô*' (religiously clean both from dirt and from evil).

Scholars of ancient Japanese literature say concerning '*jô*' or '*sei*' (meaning something sacred): "The Japanese are blessed by their forefathers with something sacred as a side of their national characteristics". The mentioning of 'something sacred' returns to the mindset of ancient people and does not differ greatly from my discussion. Yet, the concept of '*jô*' is related to Taoist ideas and should not be interpreted simply as indigenously Japanese.

Therefore, if we widen our view, we can find the concept of '*jô*' expressed throughout the Asian world, and we can understand that it does not correspond to the English word '*clean*'. '*Jô*' is not a product of human hands, but only acquires meaning when seen within religious thought. The awareness of such a '*jô*' is backed up by instincts at psychological level and is hard to understand as a concrete, physical entity.

When modern technology was introduced to a culture accustomed to '*jô*', the word could not function as a direct antonym of 'pollution', which can be regarded as a negative product of modern times. If we rely on the '*jô*' culture to solve environmental problems, we involve in the religious foundations of that culture—the consciousness of *kami*.

6 Perceptions Common to the East and the West

In Western culture, the term "environment" as something surrounding man was born from the dualistic antagonism between man and nature. In the East, the relationship of man and nature is reflected in the Buddhist concept of the universe; for example, there is a famous phrase in the Avatamsaka Sutra "… know that a tiny world is a vast one and vast world is a tiny one… There is a whole universe in a single drop of water, a whole eternity is condensed in the momentary blink of a star" (Fig. 20).

This Eastern view is a point of contact with what Paul Vidal de la Blache in his environmental theory sees as relation between different phenomena of nature and humans. According to Vidal, humanity exists in the "close correlation between nonliving matter and living organisms," and "is a part of the chain formed by that correlation, being in its relation with the environment at the same time active and passive, in most cases not being easy to determine up to what extent it is one or the other".

The chain of correlation noted by Vidal resembles the worldview of the Avatamska Sutra. We can interpret Vidal's phrase in the following way: if the world

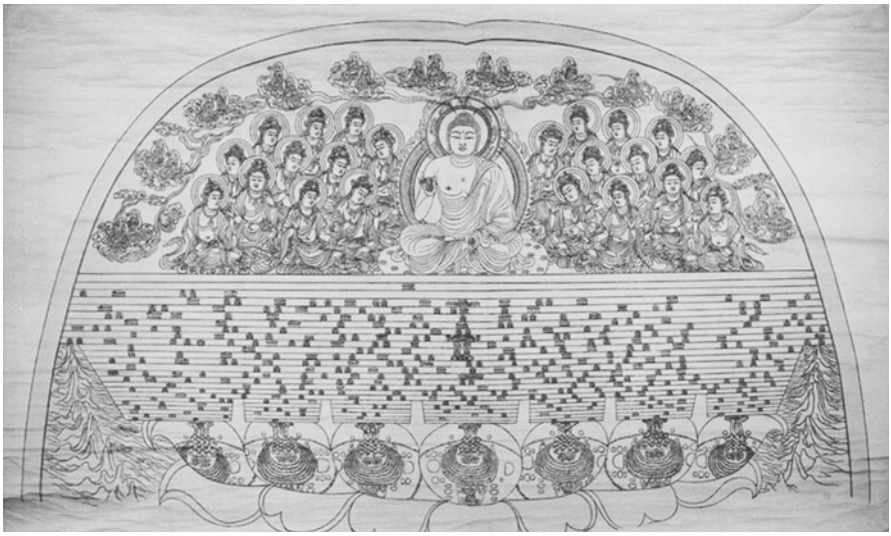

Fig. 20 Line engraving image copying of the lotus petal of the great status of Buddha. *Source*: Nara National Museum

is a rope, a knot of its threads is a tiny world, yet this little knot is related to the long rope. Thus it seems equivalent to the phrase "a tiny world is a vast one and a vast world is a tiny one" and to the imagery of a universe in a single drop of water mentioned in the Avatamsaka Sutra.

In this way, the writings of a modern geographer on 'environmental' correlation meet the world concept of the East.

On the other hand, Ryô Namikawa (1979) writes that we can find the Avatamsaka thought reflected in William Blake's (1757–1827) poetry.

> To see a world in a grain of sand,
> And a heaven in a wild flower,
> Hold infinity in the palm of your hand,
> And eternity in an hour.
> (William Blake—Auguries of Innocence)

Such an encounter between the East and the West helps us understand that modern environmental problems are related in the formation of the whole, as elements of a rope. There is no distinction here between man and nature. Everything that exists is interrelated and part of the world.

Even a small river is connected to the world, and polluting a stream pollutes the world. Even exhaust from a mini-car degrades the whole atmosphere. The person who pollutes a river or the air is part of, not outside of, nature and is cutting the chain himself or herself. Thus teaches the wisdom of Avatamsaka, the sutra created in 400 BC.

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The Tradition Wisdom of the Chinese Calendar and Urban Development in Ancient China

Ge Jianxiong

Abstract For the past 2000 years or more, the Chinese people have survived and developed through hard work and traditional wisdom. One example of such wisdom is the creation of the Chinese calendar and the system of 24 *Jie Qi*, which provided guidance and management for agricultural production. Another example is a method of urban development that guaranteed stability and prosperity for the empire.

Keywords Canal • Chinese calendar • Jie Qi • Traditional wisdom • Urban development • Water transportation

1 Introduction

During the early years of the Christian Era, the Western *Han* (汉) Dynasty had a population of about 60 million. By 1853 AD, the total population in the area of present China was about 430 million, seven times of the former number. This large population was entirely supported by the food produced by the Chinese people, based on local agriculture. Although the territory of the *Qing* (清) Dynasty is rather larger than that of the Han, the agrarian area had not been increased significantly. This is the result of arduous work and high degree wisdom of the Chinese people and no doubt a miracle in human history. I would like to describe the Chinese calendar and urban development as two examples of this wisdom.

G. Jianxiong (✉)
Institute of Chinese Historical Geography, Fudan University,
220 Handan Road, Shanghai 200433, China
e-mail: jixgek@aliyun.com.cn

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2 Role of the Chinese Calendar and *Jie Qi* (节气) in Ancient China

2.1 Physical Environment and Historical Background of Ancient Chinese Agriculture

Most of the Chinese agrarian area was influenced by the East-Asia monsoon and the climate was changeable. Historically, floods and droughts have always happened sequentially or simultaneously in different areas. Other unusual weather or natural calamities such as insect or locust, plague, wind damage, frost, snowstorms, earthquakes, landslide, erosion, dust storm have also occurred. You can hardly find a year without any natural disasters in Chinese historical documents, archives or local records.

Moreover, the country was vast, covering thousands of miles from north to south and from east to west with great variety in terrain, landform or landscape. The environment and situation for agriculture production varied considerably by region during ancient time when transportation and communication were very difficult. Even if fully centralized by imperial rule, the government failed to manage the farming in a unified manner.

2.2 Development and Improvement of the Jie Qi *System*

Thanks to the creation and improvement of the Chinese traditional lunar calendar and 24 divisions of the solar year, agricultural seasons came to be much easier to be organized even for individual farmers in the remote and isolated area. The lunar calendar may be traced back to as early as the *Xia* (夏) Dynasty, which spanned the twenty-first through sixteenth century BC. It was thus also named the *Xia* Calendar. Actually, this calendar is a combination of lunar and solar. Although the duration of one month is determined by the moon's orbit around the earth, that of one year is generally based on the orbit of the earth around the sun. A lunar month is 29 or 30 days and the average year only 354 or 355 days, shorter than the solar year. To reconcile the duration of a real year and the average year, an intercalary month is added seven times every 19 years. Thus, a leap year has 13 months and is as long as 383 or 384 days.

By watching the moon change, even a common farmer could determine the length of a month, because it is rare to fail to see the moon over a month. In contrast, change of a solar year could barely be detected by most farmers. This is because regulations for setting the intercalary month and leap year are so complex that only astronomers had the ability to observe and calculate.

The farming season is usually connected with the position of the earth in its orbit around the sun. However, it was difficult to inform farmers of specific days or seasons for agricultural production, even if a calendar book was available. Agriculture was always the fundamental production in ancient China. This is why monarchs and experts were so anxious to discover a solution to the problem of communication. As a result, the *Jie Qi* came into being, with 24 days specifically dividing the solar year.

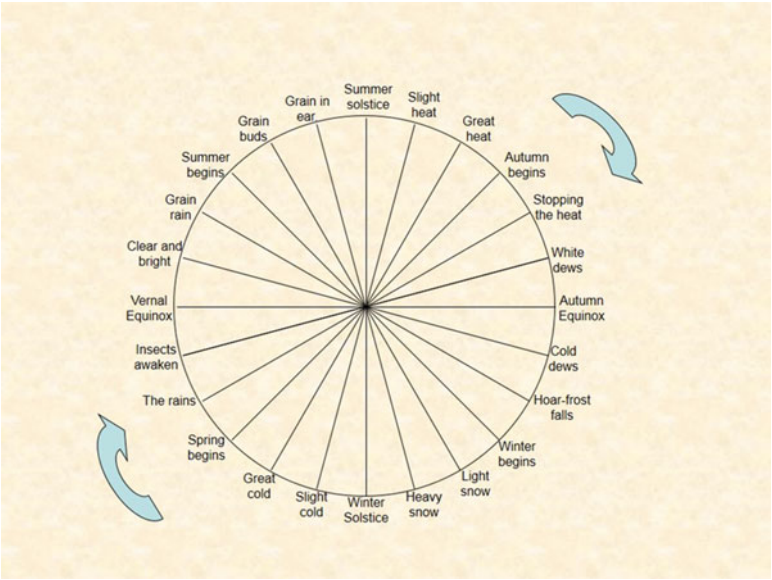

Fig. 1 Twenty-four divisions of 24 Jie Qi (节气)

The *Jie Qi* system is mainly based on the environment of the Yellow River Basin, and may be traced to as early as the Spring and Autumn Period (770–476 BC). At that time, four days of mid-spring, mid-summer, mid-autumn and mid-winter had already been fixed and named. By continuous supplementation and improvement, the 24 days of *Jie Qi* were completed and each of their astronomical positions fixed during the *Qin* (秦, 221–206 BC) and early Western *Han* dynasties (206 BC–8 AD). This was recorded in the *Tai Chu* (太初) Calendar compiled by Deng Ping (邓平) and his colleagues in 104 BC. From then on, the *Jie Qi* has been included in all Chinese traditional calendars, without exception.

Starting from zero degree of the ecliptic meridian, every 15° of sun movement corresponds to one *Jie Qi* (Fig. 1). Thus, when the sun turns 360° every year, the 24 *Jie Qi* are completed. Based on solar movement, the date of every *Jie Qi* in the current Gregorian calendar is usually fixed. In the first half of the year, it falls on the 6th or 21st day of the month; in the second half, it falls on the 8th or 23rd day. Variation is generally less than one or two days.

2.3 Names and Meanings of Jie Qi

The names and meanings of the 24 *Jie Qi* are as follows:

1. *Li Chun* 立春 Beginning of spring.
2. *Yu Shui* 雨水 The rains. The rainy season begins and rains increase gradually.

3. *Jing Ze* 惊蛰 Insects awaken. The first spring thunder wakes animals from their hibernation.
4. *Chun Feng* 春分 Spring equinox. When day and night are of equal length in spring.
5. *Qing Ming* 清明 Clear and bright. The daytime is clear and bright.
6. *Gu Yu* 谷雨 Grain rain. Timely and full rains nourish grains.
7. *Li Xia* 立夏 Beginning of summer.
8. *Xiao Man* 小满 Grain buds. Summer crops bud and grow.
9. *Mang Zhong* 芒种 Grain in ear. The ears of summer crops grow and ripen.
10. *Xia Zhi* 夏至 Summer solstice.
11. *Xiao Shu* 小暑 Slight heat. The hot season begins.
12. *Da Shu* 大暑 Great heat. The hottest days of the year.
13. *Li Qiu* 立秋 Beginning of autumn.
14. *Chu Shu* 处暑 Heat stops.
15. *Bai Lu* 白露 White dew. The weather turns cool and dew appears at dawn.
16. *Qiu Feng* 秋分 Autumn equinox. When day and night are of equal length in autumn.
17. *Han Lu* 寒露 Cold dew.
18. *Shuang Jiang* 霜降 Hoar frost falls.
19. *Li Dong* 立冬 Beginning of winter.
20. *Xiao Xue* 小雪 Light snow.
21. *Da Xue* 大雪 Heavy snow.
22. *Dong Zhi* 冬至 Winter solstice.
23. *Xiao Han* 小寒 Slight cold.
24. *Da Han* 大寒 Great cold.

2.4 Significance and Contribution of Jie Qi

It is clear that every name and meaning of the *Jie Qi* represents characteristics of weather, phenology or landscape. As a result, each *Jie Qi* may be used in farming as an indicator, guide, schedule or warning. Each is associated with certain farm work such as plowing, sowing, weeding, fertilizing, insect treatment, picking or reaping, or with certain crops like rice, wheat, bean, millet, sorghum, mulberry, hemp, tea, lacquer or rapeseed. Although *Jie Qi* was mainly adapted to the weather and environment of the Yellow River Basin, it could be practiced outside that area by simple time adjustment, according to local experience. In fact, it was ubiquitously applied in ancient China. Proverbs, folk sayings, folk songs, and popular poems connected with the *Jie Qi* were widespread; it was practiced in farming and used as a guide to daily life.

After establishment of the *Jie Qi* system, management and guidance of agricultural production became more effective and convenient throughout the extensive Chinese empire. A new almanac was published and widely distributed before the new year. From the emperor to grass-roots officials, the chief measure to be taken was simply to ask farmers not to miss the seasons designated by the *Jie Qi*. Hundreds of millions of Chinese farmers maintained this traditional method until the early twentieth century.

3 Urban Development and Water Transport in Ancient China

Ancient China boasted capital cities like Chang'an (长安), Luoyang (洛阳) and Beijing (北京) renowned for their magnificent palaces and symmetrical layouts (Fig. 2). Traditional wisdom in urban development during the pre-modern period had three aspects: utilization of natural and artificial water systems, reasonable development outside city walls, and overall consideration of the natural environment.

3.1 Change and Development of City Layouts

With archaeological excavation and research in recent years, Chinese urban history has been repeatedly rewritten. Urban relics have been found not only in the Yellow River region, but in the Yangtze River region and elsewhere.

Governments of the *Xia* (twentieth–sixteenth century BC), *Shang* (商, sixteenth–eleventh century BC) and *Zhou* (周, eleventh century-256 BC) dynasties implemented enfeoffment systems, by which princes and ruling officials were given land in exchange for pledges of service. In this way, each city enjoyed relative independence, and administrative functions focused on urban planning. The most important sections of cities were dominated by palaces of the nobilities and officials, and by

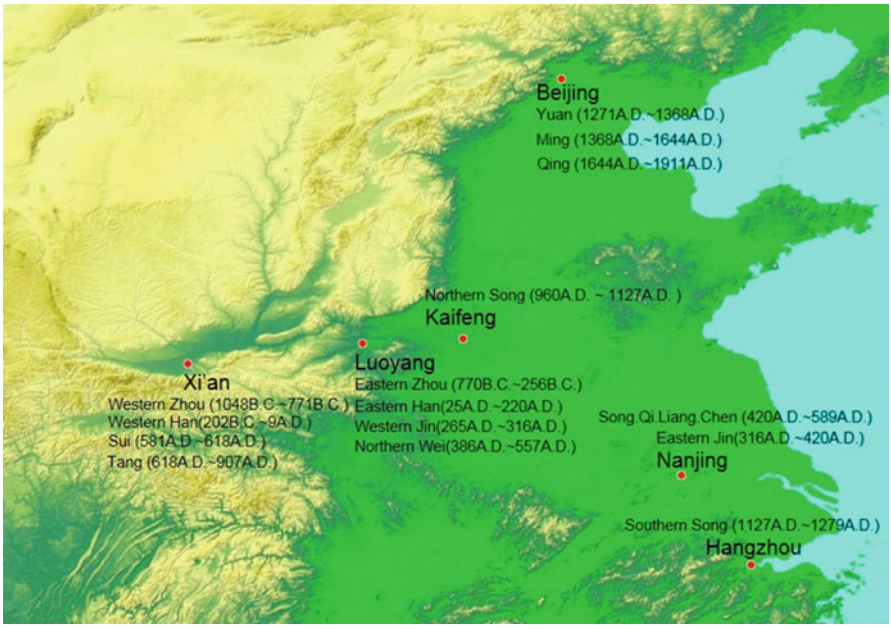

Fig. 2 Eastward shifting of empire capitals

administrative and ritual sites. Cities were typically surrounded by walls, and some even had defensive fortifications. Most cities were very large and even contained farmland. From a modern perspective, ancient cities were not well planned. However, for their time, they met the needs of the people, especially considering that the populace needed walls and defensive fortifications to ensure their safety.

After the *Qin* Dynasty (秦, 221–206 BC), the enfeoffment system was replaced by a centralized system and the political functions of cities became more evident. During the Western *Han* Dynasty (206 BC–8 AD), more than 1,500 towns nationwide were stratified into several administrative levels; each town was controlled by a higher level. Each city had administrative bodies and constructed city walls. Political bodies and these walls were two essential elements of cities in that period.

Chang'an, capital city of the Western *Han* Dynasty, was built on the ruins of the *Qin* capital. One third of the city was occupied by the emperor's palaces, and another third dominated by warehouses, government offices, barracks and prisons. The remaining one third was for dwellings of the population. The same structure also applied to Luoyang, capital of the Eastern *Han* Dynasty (25–220 AD). Though lacking large palaces, government offices and other administrative institutions again occupied most land in non-capital cities. Therefore, the quality of life for common people in cities was not as good as in rural areas. In agricultural societies, many people worked on farms and did not wish to leave their hometowns. Except for those who originally lived in cities or had to live there out of necessity, people preferred to live in the countryside.

At the end of the Eastern *Han* Dynasty, the empire was separated into several parts and suffered from continuous civil wars, which greatly damaged the cities. War forced many to migrate to cities from rural areas, thus increasing the urban populations and making them more culturally diverse. At the same time, with the introduction of Buddhism to China, temples became necessary elements in cities. Taking Luoyang, capital of the Northern *Wei* Dynasty (北魏, 386–534) as an example, records indicate that more than 1,000 temples and pagodas were built there. The city also attracted numerous businessmen and immigrants from the Western Regions and from as far away as the Roman Empire.

Chang'an, capital of the *Tang* Dynasty (唐, 618–907 AD), had various functions, with a focus on business. Occupying more than 80 km^2, Chang'an was one of the largest and most populous cities in the world at that time. However, the closed city structure limited its commercial and economic development.

3.2 Expansion Outside City Walls

The aforementioned limitations were finally overcome in the *Song* Dynasty (宋, 960–1279), as shown by many historical records and the painting *Along the River during the Qingming Festival* (清明上河图). That painting reflects the urban area of Kaifeng (开封), which had spread beyond the city walls to suburban areas. City commercial development offered more convenience to residents. Further, transportation

made it much easier to travel to the cities, and promoted communication between urban and rural areas. The invasion of the *Nuzhen* (女真) expelled the *Song* regime to South China, and made Hangzhou (杭州) their temporary capital. As a local prefectural city, Hangzhou could not contain the royal family, central government and huge rush of immigrants, and was forced to expand outside the city walls. As a result, settlements and markets there were more numerous than those inside the walls, and these had a more active and prosperous role in metropolitan Hangzhou.

According to the research of domestic and foreign historians, economic and cultural development during the *Song* Dynasty reached a higher level than in any previous Chinese dynasties. This can be seen in paintings and other descriptions. Subsequently, the urban planning model was adopted by other cities in later dynasties, such as cities in the Yangtze River region (especially small towns).

Most provincial, prefectural and county-level cities attempted to use nearby rivers. City layouts were designed according to the natural environment and not to the classics or authorities. These cities were usually wealthier and more prosperous, and attracted more residents. Small towns located on the plains, alluvial areas and water networks enjoyed more convenient transportation and lower prices for livelihood. This is why most cities without river or canal connections in north and northwest China gradually declined.

3.3 National Capital and Water Transport: Chang'an-Luoyang Period

It was not until the establishment of the *Qin* Dynasty, the first centralized empire in Chinese history, that its national capital Xianyang (咸阳) became the real political center of the country. As the location of the royal family and of a centralized and bureaucratic government administering a vast land, the city and environs always housed a large number of officials, army men and civilians. Since the surrounding basin failed to provide enough grain to support the increasing population, the food supply problem had to be addressed and solved from the start. Fortunately, the middle and lower reaches of the Yellow River and lower reach of the *Wei* (渭) River could be used as waterways. Grains from Guangdong (关东, area east of the Taihang 太行 Mountain), the main agricultural production area, were gathered by boats from the tributaries and canals to the Yellow River and brought upstream to Xianyang. The Western *Han* established its national capital in Chang'an, very near Xianyang. Owing to the expanding population and necessity for northwestern frontiers, the grain amount carried via water transport from Guangdong to Chang'an was typically 4 million *hu* (斛, approximate 20 kg) annually, with the maximum exceeding 6 million *hu*. We can hardly imagine that this grand city could have persisted and thrived without water transport, mainly along natural river courses.

Nevertheless, upstream boats had to traverse the San Men (三门) Gorge, where roaring torrents and steep cliffs damaged boats and caused heavy loss of grain and

lives. The Eastern *Han* Dynasty moved its capital to Luoyang, downstream of the gorge. A principal consideration was to avoid this dangerous gorge and make transportation more convenient and reliable. This is why the *Sui* (隋) and *Tang* (唐) dynasties established Luoyang as their eastern capital, but maintained their national capital at Chang'an. Whenever natural calamities happened in the basin around Chang'an, the emperor used to lead his subjects and local residents moving to Luoyang for more convenient and economic food supply. In 605 AD, Emperor Yang Di (炀帝) of Sui forced more than one million laborers to dig the Tong Ji Canal (通济渠) and dredged the Han Guo Canal (邗沟) from Luoyang to Jiangdu (江都, present-day Yangzhou 扬州) and connected the Yellow River, Hui (淮) River and the Yangtze River. Further attempt was accomplished by the new Jiangnan (江南) Canal from the south bank of the Yangtze River to Hangzhou (杭州). The new canal was used by the emperor as a comfortable waterway for his luxurious travel, and also served as a new route for grain transport. Three years later, another new project, the Yong Ji Canal (永济渠) was dug from the north bank of Yellow River near Luoyang to Zhuo Jun (涿郡, present-day Beijing), to guarantee food supplies to the huge army dispatched to North China.

The late *Tang* period saw further decline of the Guangdong region. This was caused by wars, natural calamities, and agricultural and economic development in the area south of the Huai River and Yangtze River Delta. Food supplies and daily necessities of life mainly relied on water transport from the Jiang (江, Yangtze River) and Huai rivers. Whenever this transport line was interrupted, the capital suddenly became desperate, and even the royal family could barely maintain daily life. In 904 AD, the national capital was forced to move from Chang'an, and it never returned.

3.4 National Capital and Water Transport: Kaifeng–Beijing Period

From 907 to 1127 AD, Kaifeng was the capital of the Five Dynasties and Northern *Song* Dynasty. Compared with Chang'an and Luoyang, Kaifeng was more favorably located within the river and canal system. Travel distance was shortened and the waterway improved. As a result, grain supply to Kaifeng was always adequate, and capable of supporting the capital of an empire with one million people. Thanks to a water system with the Bian Qu Canal (汴渠, part of the former Tong Ji Canal) as its main course, Kaifeng became a hub of water transport in the Yellow River reaches and a prosperous commercial center, before the Nezhen invasion.

When Zhu Yuanzhang (朱元璋) founded the Ming (明, 1368–1644 AD) Dynasty in Nanjing (南京) in 1368 AD, he fully understood that his capital was too distant from the real center of the empire. Kaifeng was one of his preferences, and was established as the northern capital. However, he soon found that Bian Qu and other canals were heavily silted and water transport was very difficult. He had to give up his plan, and Kaifeng finally lost its position of prominence.

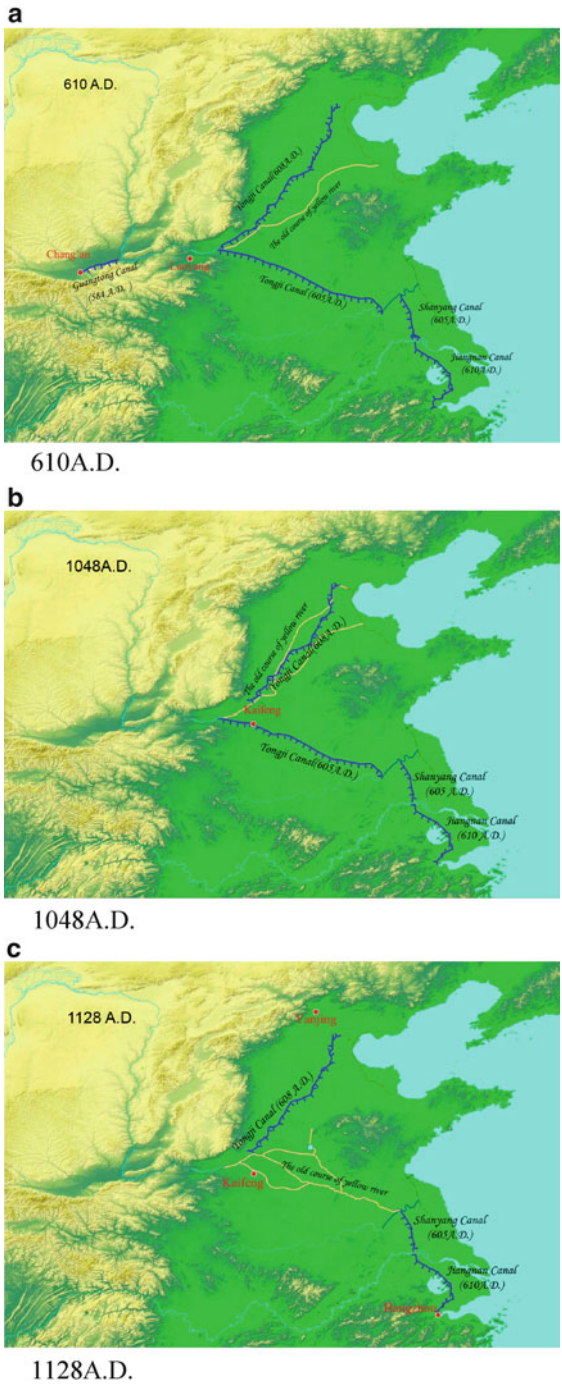

Fig. 3 Canal system in different years. (**a**) 610 AD; (**b**) 1048 AD; (**c**) 1128 AD; (**d**) 1293 AD; (**e**) 1566 AD; (**f**) In the 19th century

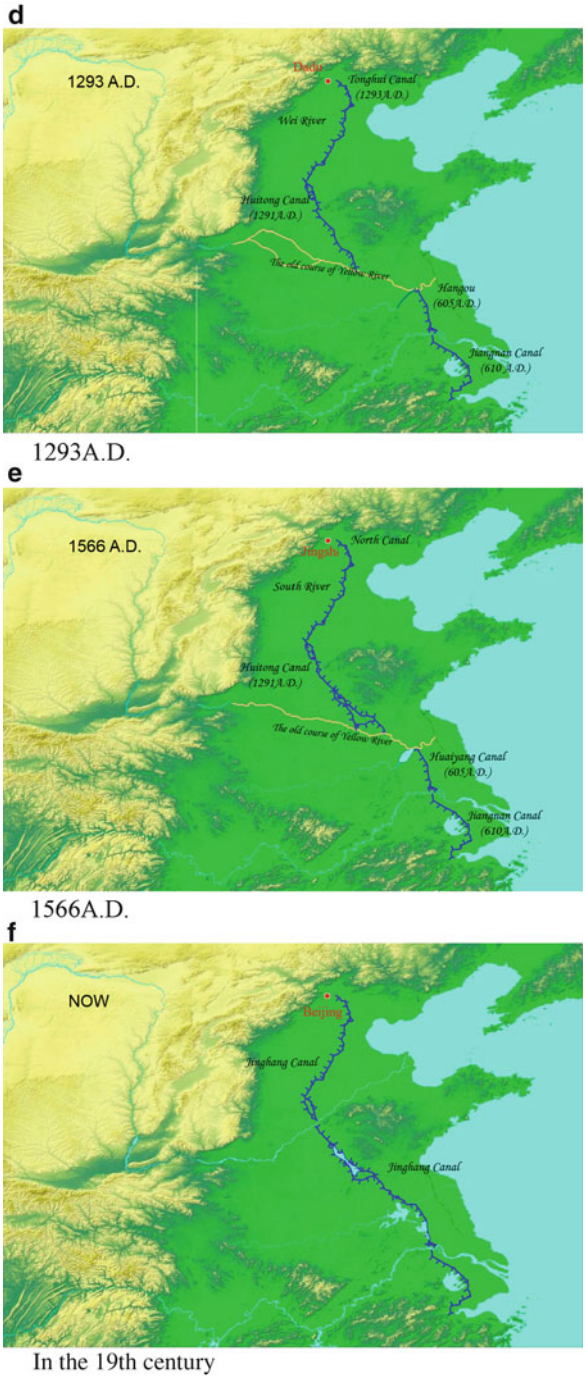

Fig. 3 (continued)

Beijing has been the national capital of China since the *Yuan* (元) Dynasty (1279–1368 AD). As a large city in relatively dry and cold North China, its most serious problem is supplying food to its large population. Soon after reunification, the *Yuan* government began to dig a new canal to connect the former Tong Ji Canal and Yong Ji Canal, originally dug by Emperor Yang Di of the *Sui* Dynasty in the early seventh century, to ultimately form the Grand Canal from Beijing to Hangzhou. Grains from the Yangtze River reaches were brought annually to Beijing and the northern frontiers by the Grand Canal (Fig. 3). The largest annual transportation volume was 3.34 million *shek* (石, approximate 50 kg) during the *Yuan* period, which rose to 4 million *shek* in the *Ming* Dynasty. From then on, maintenance and improvement of the Grand Canal remained a first priority of the central government. This grain supply canal system served the empire as long as 700 years and was eventually replaced by the modern maritime and railway transportation in the turn of twentieth century.

A Better Future for Humanity: A Viewpoint From Geography

Jean-Robert Pitte

Abstract Many people are convinced there are too many humans on Earth, that food and energy resources are now extremely limited, and that global climatic change—often called *global warming*—will necessarily have catastrophic consequences. There is also general consensus that productive dialog between civilizations is impossible, that good relationships among people will never happen and that the world's poor will always be crushed by the wealthy.

Prophets of doom are numerous in all fields, such as geology, biology, history, demography, economy, and political science. Samuel Huntington is among the most famous of these. Moreover, scientifically uneducated journalists and politicians (Al Gore, for example) spread questionable information through various media. This paper aims to demonstrate that Thomas Malthus was wrong two centuries ago, and is still wrong. Cleverness, imagination and geographic knowledge can create a better environment for more people. Education, social order, and an honest and competent elite can bring about peace. This is the purpose and plan of all traditional world wisdoms and philosophies, secular or religious, at least since those of Confucius and Socrates. The great contrasts in development and optimism observed across the globe may be explained by cultural analysis of societies within their own territories, with respect to their relationships with their environment, social organization, and relations with other societies.

Keywords Civilizations dialog • Education • Food • Future of humanity • Geographical knowledge

J.-R. Pitte (✉)
Institut de France (Académie des Sciences morales et politiques),
Société de Géographie (Paris), 23 quai de Conti F-75270, Paris Cedex 06, France
e-mail: Jean-robert.pitte@wanadoo.fr

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1 Introduction

With two terrible world wars and innumerable international and civil wars, events of the twentieth century have been unable to convince humanity that technological revolutions (in automation, energy, transportation, telecommunications, data processing, agronomy, health, and others) are sufficient to create a harmonious world and the best possible future. Nevertheless, extraordinary and positive events have taken place since the end of World War II. Some of these include the inception of the European Union (EU), the result of which has been a 65-year period of peace on this once bloody continent. Such a union seemed improbable after countless wars since ancient times. Also to be included are the end of apartheid in South Africa and the Cold War, and the fall of the Iron Curtain in Eastern Europe. The totalitarian Soviet Empire disappeared without a single casualty. The Chinese and Indian populations emerged from situations of severe underdevelopment, and began a trend of incredible economic growth. The 2.5 billion inhabitants of these countries are in a state of progress, at least from a material standpoint. Technical advances devoted to human services have never been so rapid and efficient. People, goods and information have never moved so easily and cheaply around the world.

There are currently more than 7 billion people on Earth, with an average life expectancy of 69.6 years. This represents a better standard of living than that experienced by the global population of 2.5 billion in 1950, who had an average life expectancy of only 46 years. Of course, about one billion of our contemporaries are still living well below the poverty line, seriously lacking food, drinkable water, health care, education, and the most elementary life comforts. This estimate represents a great many people and a terrible failure for humanity; however, this number was the same half a century ago, at which time the global population was one third of that at present. At that time, demographic specialists were very pessimistic and certain that the absolute maximum possible population of the world had been reached (de Castro 1951; Beaujeu-Garnier 1965).Causes of starvation were the same as today, exclusively linked with bad governance, ignorance, and lack of collective will and spirit of responsibility.

2 Agriculture and Culture: A Humanistic Future for World Agricultural Production[1]

Recent times have been marked by a dual rise in the price of hydrocarbons and agricultural commodities, primarily cereals. The press, various parties and associations linked to the green movement, and a number of scientists [from the earth and life sciences rather than from the humanities (economics in particular)], have relayed reports of these price increases with precision, albeit shedding a disturbing

[1] This section is developed in Pitte (2010). An updated version is presented here.

light on them.[2] A link to climate change, or what is believed to be known about it, has been suggested. Fear of the future has taken hold of public opinion, as it is readily wont to do. This is also the case for world leaders, who have replaced the art of governing and looking to the future with more precautionary principles. It is regrettable that this principle was only introduced in the French Constitution in 2005; this has been the case in Brazil since 1988 as well as in Sweden and Germany, although in the latter two countries it is not at the constitutional level. Much energy is being expended attempting to guess what will happen, rather than pondering which actions are wise. This is not a good sign for a civilization.

2.1 Rethinking the Environment Concept

The old millenialist fears about terrible signs heralding the end of time have made a comeback. Malthus' theories have been revived and the Earth is allegedly overpopulated. The population has increased from 3 to more than 7 billion over five decades. Brazil, Russia, India, China and South Africa (the BRICS nations) may not have overcome all their subsistence problems, but they are no longer suffering the terrible famines that afflicted them in the past. Thirty million Chinese died of starvation between 1958 and 1962; at the same time, that country was exporting wheat. India suffered its last deadly famine in 1966. Today, these five countries represent 40 % of the world's population and more than a quarter of the worldwide gross domestic product (GDP); the latter is likely to rise to 40 % in 2025, according to the International Monetary Fund. These countries are responsible for more than half of global economic growth, a figure likely to increase to 60 % in 2015.

The only countries still suffering famine are in a state of civil war or are ruled by incompetent, evil or corrupt totalitarian regimes. North Korea is the best example of this. Severe famines accompanied by episodes of cannibalism have occurred there in recent years; meanwhile, on its doorstep, smaller and more densely populated South Korea, whose people belong to the same ethnic group, has become a major world power. No other geographic contrast is starker or more senseless.

The environment is not in reality independent of mankind, nor one that the latter ought to venerate. The only civilized way to look at this is to recognize that the environment is the human's environment. Humans have every right and are endowed with sufficient intelligence to grasp the fact that short-sighted use of their habitat may redound against their own survival. It is up to mankind to deploy know-how, reason and responsibility, as in the conduct of individual and social affairs. Geography provides a variety of potential answers to a given environmental problem; for example, climatic evolution, forms the basis for a diverse view of the world, and is currently the sole optimistic answer to the challenges of globalization, which is an undeniable fact that cannot be opposed without making excessively harsh and

[2] There are some notable exceptions such as in France, Claude Allègre, geophysicist, former Minister of Education, Research and Technology and member of the French Academy of Sciences.

Table 1 World food output (kcal/person/day)

Year	1963	1973	1982	1992	2002	2013
World	2,295	2,428	2,593	2,708	2,804	Approx. 2,900
Vegetable origin	1,944	2,064	2,207	2,291	2,336	Approx. 2,400
Animal origin	351	365	386	417	468	Approx. 500
Population (billions)	3.195	3.907	4.575	5.412	6.205	Approx. 7.100

Source: FAO

pointless sacrifices. All we must do is realize our challenges and potential, and then take advantage of and adjust to them by adopting original strategies. The job of a geographer is to enable us to live better on the planet.

French geographer Yves Lacoste wrote a book that attempted to demonstrate that the primary purpose of geography is to enable humans to make war (Lacoste 2012). His dictum was strictly accurate. The science of geography owes much to the princes and strategists who promoted and used it for military ends, to make territorial conquests. Nowadays, geographic knowledge is crucial to peacemaking. It is a pity that so many world rulers and staff that surround them have such an embryonic state of geographic knowledge and curiosity.

The geographic perspective is applicable to both cultural and political spheres and, in that of economics, particularly agricultural production. It is the only perspective that makes possible transcendence of the currently prevalent pessimistic view of the world and envisages the future in a reasonably optimistic light.

2.2 Farming can and Must Provide Mankind with Sufficient Food

Goods produced by agriculture have many uses in fuel, clothing and other industries; however, their prime function is to feed people, to build human strength daily and maintain good health.

At the rate of 2,500 calories per day, which is on average sufficient to feed an individual, world agriculture produces more than enough to feed the entire world population, thanks to constant agronomic progress. Despite this surplus, over 800 million people are hungry, which is more than 10 % of the global population. This is much less than in 1970 (34 %) or even 2000 (15 %), but it remains an unacceptably high percentage. This is especially so because this rate is unequally distributed; for example, 28 % of the 800 million who lack sufficient quantities of food live in Sub-Saharan Africa. At the same time, an important percentage of inhabitants in developed countries are overweight or suffering from obesity, particularly in the United States. Moreover the proportion of foods of animal origin is growing continuously, and animals require nearly three times their caloric value in vegetable feed.

It is thus crucial that the prognosticating pessimists in the world understand that the earth can properly feed all its inhabitants simply by making better use of current farming output (Table 1).

How have we arrived at such extraordinary agricultural production, initially envisioned in the 1960s by the Club of Rome global think tank and Food and Agriculture Organization (FAO) of the United Nations? First is the use of fertilizers and pesticides. These may be criticized, especially when used excessively and indiscriminately, but certainly not demonized. Second is via the selection and hybridization of living species, a process in which green movements in Mexico, India and all Asia are involved. Last is via China's shift toward a market economy, a political strategy that has freed up considerable human energy.

Given the above, is it reasonable to criticize genetically modified organisms (GMOs) a priori, on the pretext that the technology involved reaps profits for the multinational company Monsanto? Let us imagine the same being said of Boeing or Airbus. Even the most hardline unions would be shocked, considering how many jobs and how much wealth those corporations generate, not to mention the freedom of travel that they enable to become more widespread. Too many ill-informed views are being voiced regarding GMOs, refusing on ideological or pseudo-ethical grounds to back research that will one day permit increased farming yields and decreased water requirements, chemical fertilizer input, and pesticides.

Of course, there are risks, but there are also risks in the health or nuclear power industries. Scientific researchers are there to assess these risks and formulate methods of obviating them. Political decision makers must keep abreast of discoveries made by experimental science. It is astounding that obscurantist militants should be able to claim the right to destroy the work of researchers, using methods not far removed from those of the Inquisition.

Although endeavoring to produce sufficient quantities, global (and particularly French and European) farming must account for its production costs and increasingly wean itself from public support. Real or disguised subsidies are intended to cope with temporary difficulties in various areas of production, or with poor harvests or plummeting prices. These subsidies are also there to aid a switch to a different branch of farming or a costly change of strategy. They cannot permanently support entire regions or economic sectors. EU and World Trade Organization operating rules are a move in the right direction.

Clearly, this goal of financial autonomy for the industry cannot be achieved all at once, either in wealthy or poor countries. In the latter, Africa in particular, there should even be an intermediate stage of intensive aid to good farming practice, undiverted if possible. Too many rural areas in Africa and Latin America, and indeed some parts of Asia, have been voided of their peasantry. These individuals have departed to a hand-to-mouth existence in increasingly monstrous, unmanageable cities. Of course, this necessitates thought about training for country dwellers and trade networks. The emergence of a responsible elite with integrity in a certain number of countries is another requisite. Sadly, it must be admitted that in this respect, Africa has been marking time for half a century.

One last point: farming can and must provide the global population with sufficient food, but also do so in a balanced manner in terms of consumer health. A dietary education drive should be conducted in many countries (poor and wealthy) having unbalanced eating habits (excess fats and sugars). This drive must be devised in conjunction with the food production and processing industries.

2.3 Farming Must Also Nourish the Mind

It might seem almost indecent to talk about food quality in terms of taste and culture while 800 million people worldwide are going hungry, but then why not? The poor, too, have the right to quality (Pitte 1998). Indeed, a number of poor regions have full-fledged daily cuisine based on local, genuine produce, the fruit of the soil. This food strikes a profound harmony within the people who produce it, as within those who eat it, who are often the same.

Indeed, it cannot be considered healthy to pay attention solely to the caloric value or balance of ingredients (proteins, carbohydrates, fats, vitamins, mineral salts, fiber and water) of one's food intake. A balanced diet must also provide pleasure, even joy, and thus give rise to conviviality via flavors that arouse emotions. This is an aspect of the food issue that is addressed all too little, and this is regrettable. If too many Americans suffer from obesity, it is because they have become compulsive consumers of rich, fatty, sugary foods. These are turned out by an industry that has incessantly standardized, identically reproduced, and eliminated seasonal, annual and geographic variations of their marketed products.

Despite the enormous talent of its engineers, sales managers and advertising departments, the food industry has thought solely in terms of the law of economies of scale—the more produced of the same standard article, the lower its unit cost. Consumers have allowed themselves to fall into this trap. Mechanically eating a pleasant but insipid and fault-free food, fully familiar to the taste buds and brain, is comforting, even if it ends in bulimia. The same applies in numerous spheres bearing on lifestyle—clothing, music, television, tourism and others.

It is very easy to acquire automatic eating habits, especially if as infants we were fed solely on formula milk, jars of mashed baby food, pasta with industrial Bolognaise sauce, frozen pizza, hamburgers and fried chicken breasts, all washed down with syrupy brown soda. Industry and the major distribution chains have put so much technology and effort into producing labor-saving food, as detrimental to bodily health as it is to spiritual gratification of consumers for whom it is intended. Why should consumers try a different diet when they have never known anything else? Life is hard enough, especially when one is not well off. Why should they make an effort while shopping, cooking and eating their meals to differentiate, identify, chew, understand and exercise their intelligence and imagination, when they can buy easy (at first glance) and inexpensive food? In fact, a good quality-to-price ratio is often just an illusion.

The food processing industry and distributors are well aware of the lack of cultural content of various articles that they market. Let us not talk in terms of cynicism on their part, but of a meshing of corporate goals and approaches. In advertising, artificial use of landscapes and references to heritage of the past and our grandmothers' culinary creativity is a sign of nostalgia, of a muddled awareness that an essential, dream component is missing from a wide array of current eating habits. There is something poignant about those television advertisements for an industrially produced cheese featuring a cute little girl boldly telling her parents (who have given her none)

"me too, I want some flavor, a real one!" Sad to say, this amusing sketch promotes a sort of scored disk of cheese that has been strictly uniform ever since it was invented. It is the fruit of skilled calculations and satisfaction tests, but dead, killed by a disheartening lack of variation in its flavor. Let us not forget the fable of 1719, in which Antoine Houdart de La Motte penned these profound lines that people of our age can never adequately ponder:

> What great entertainment lies in diversity. . . .
> Boredom was born one day of uniformity.

Truly humanist food, by which I mean food that reflects the wealth of human intelligence and sensibility, must avail itself of a very broad range of subtly differing flavors that can vary from one moment to the next and from one location to another. It must express the personality of its area of origin, and of the people who have used their culinary skills to prepare it with loving care and mutual generosity. Food has to reflect the nature of human life; it must be diverse and changeable, to paraphrase Montaigne. A utopia for rich men? By no means; food is something consumers need and producers can deliver, and it can be profitable to boot. All things considered, food is the only option for what we have now decided to call "sustainable development".

2.4 Pleading the Cause of a Geographical Diet

When a food is in the form of a beverage, it takes on increased cultural value and evocativeness when it conjures up a place, landscape, environment, climate, vintage or the personalities of those who produced it, themselves heir to a living heritage that their own inventiveness regenerates.

Flavors have always had this evocative power, even in the days when we travelled far less than today. Think of the thrill stirred up by spices, a feeling present since classical times. Everyone in Renaissance Paris knew that the best white bread was made of wheat from the French plains, kneaded by the bakers of Gonesse. Not long after, villages in the Île-de-France region specialized in particular crops known and favored by all Parisians—peas from Clamart, haricot beans from Arpajon, and cherries from Montmorency. Wines have obviously always been part of this mode of consumption, with strong geographic ties. The lower classes drank and favored cheap wines, if any were produced locally. Better-off consumers, eager to extend the spectrum of their gastronomic pleasures, turned to wines from further afield, sometimes much further.

This food philosophy is currently expressed by the very French concept of *terroir*. This idea has harsh critics who deem it antiquated, even Vichyist, and beyond the means of the less fortunate in this period of diminished purchasing power. This is a flagrant untruth, motivated by the desire to change nothing in the current production methods, which suit some captains of industry and food-processing giants. This also represents a dangerous stance in these days of international

competition and unstoppable globalization. We must not believe or hope these processes can be halted, given all the benefits that mankind can draw from them.

There is no possibility of retreating snugly into defense of *terroir* or, more generally, of cultural identities. That can only lead to a blinkered view of the world and, at times, to violent disputes. Mankind may need roots, but man is also nomadic and equipped for cultural cross-breeding. All *terroirs* have changed boundaries and orientation during their histories, as is only right. Nevertheless, the fact that a particular product is recognized for a unique personality that is bound up with its geographic area may be its trump card. Areas that have poor soil and climatic conditions first spring to mind, as do others. It is precisely with a view to turning this difference to good account that the association between particular solid foods (such as cheese) or drinks and their places of origin has been protected by authorities for centuries. France has taken the lead in this activity, and in 1919 and 1935 gave rise to novel legislation introducing the *Appellations d'Origine Contrôlées* (AOC). Since then, many countries in Europe and elsewhere have gradually followed France's lead. Although much remains to be done, there are many producers and consumers urging authorities to move in this direction.

Doubters of the economic viability of this trend need only be reminded of the enormous difficulties faced by French wine growers in the days when many consumers were settling for mediocre table wines produced from blends of Languedoc and Algerian wines. At the same time, many bottles sporting high class labels contained potions born of unspeakable concoctions. Nowadays, producers of table wine, even honest varieties, still face difficulties. In contrast, most producers of AOC wines are making a good living without subsidies, provided they have opted for top quality and taken their own bottling and marketing in hand.

Furthermore, there are the enormous reserves of complementary resources that agritourism offers such as tastings and sales on the spot, meals for guests, accommodation and others. Turnover is currently estimated at 20 billion euros *per annum* in France and it is undoubtedly more in Italy, which has succeeded in creating great qualitative rivalry around its local produce and surrounding landscapes via the novel Slow Food movement. Some developing countries are entering this on a small scale in coffee, tea and rum producing areas. However, the development potential is huge at a time when the numbers of tourists seeking fresh sensations and contact with other countries are large. Even arable farming regions might consider adopting this movement. Péguy was won over by the charms of the "wheat ocean" in Beauce. A touch of public relations talent might pump fresh lifeblood into the veins of similarly captivating areas.

2.5 Rethinking Production Methods

Considering input from agronomy, biochemistry and the present trading economy, it is now possible to feed mankind properly, in terms of both quantity and quality. At the same time, we can foster a proliferation of crop varieties to circumvent the head-on competition that standardization implies.

In a diversified world where the agriculture industry is to be promoted and kept in balance, it will be important to alter production methods. Reducing water requirements is an absolute must in many parts of the world, until the nearly free power generated by nuclear fusion reduces the cost of seawater desalination to negligible levels. Conversely, parsimonious use of other farm inputs such as fertilizers and pesticides is currently problematic for countries and industries that make their living from them. This does not mean these inputs should be eliminated altogether. Nonetheless, this is a crucial revolution, and is the only way to encourage food crop production and export in a number of southern countries. Such a goal is not one of those noble intentions that do not make for good politics, but rather a means of balancing the global economy by enabling all people to someday sell and buy goods and services autonomously and with dignity.

The above activity represents the only way to improve harmony between the environment and man who, we once again assert, has benefited greatly since the industrial revolution in biological and chemical agricultural inputs. Mankind is on the verge of a new threshold; the sooner we cross it, the better for everyone.

High-quality vine growing, which produces expensive wines, is perhaps the vanguard of a movement ready to spread. Not only have the world's best wine growers gone over to organic cultivation, some of them have adopted biodynamic methods. One must admit that wines produced by these techniques are difficult for beginners to distinguish, although connoisseurs do not doubt their superiority. The same may be said of fruit and vegetables. Such assertions would have been the butt of criticism half a century ago. The day when we can start making these assertions about bread may be nearer than we think.

Jacques Puisais, a famous French enologist who has been doing a great deal for decades to help the French eat better, embarked a few years ago on a pioneering experiment that deserves attention. He asked cereal farmers in Beauce, the Loire Valley and Sologne to grow the same variety of wheat using organic farming methods. He then had the same baker make leavened bread with three flours derived from these harvests. The result was that the loaves had very different flavors, and the conclusion was that France is the country of bread. People come from all corners of the world to eat it. Cereal growers, millers and bakers have a duty not to disappoint bread lovers and to extol this heritage, through diversifying it by region and method. This approach is a goldmine ready for exploitation.

2.6 Rethinking Trade Networks

There is no question that the utility of global networks that liaise between producers and consumers living thousands of miles apart must be challenged, toward the mutual satisfaction of all involved. However, the necessity of these networks must be pondered on a case-by-case basis and, to that end, their real costs in terms of energy (and especially carbon emissions) must be calculated. In the process, one must consider the aid various crops may receive on various heads in its country of origin.

In poor countries as indeed in wealthy ones, it is a good idea to emphasize seasonal consumption and short supply chains, thus reducing or eliminating the number of middle men between producers and consumers. This is the best way to promote food farming in developing countries, and local production in industrialized countries. This would be in the financial interest of both farmers and consumers and would furnish a means of promoting novel, fresh, local food with ties to the landscape and local lore. There is nothing folksy or outdated about direct contact between producers and consumers. It is one way of forcing players in the economic arena to talk to each other again, to create the social bonds to which all people aspire.

Global food markets remain shrines to conviviality and the feeling of belonging. They are so well-loved and serve such a useful purpose that they have become favorite tourist spots. The same goes for buying directly from producers (including wine, fruit and vegetables, cheese, delicatessens, preserved and cooked foods). This is the principal aim, for example, of the food products labeled "Duchy" originating from Cornwall in Southwest Britain and promoted by Charles, Prince of Wales. Major distribution chains should consider this and draw the conclusions necessary to adapt their approach to the consumer quest for cultural roots. Knowing that they are providing a service and that their business can thrive at the same time should not prevent these chains from asking questions, challenging their attitudes and adjusting their sights. This would add a little extra soul, one might even say deep-felt joy, to the consumer act of buying.

2.7 Educating the Consumer

This change of course in farming, the food processing industry and trade networks is no minor matter. It calls for in-depth updates of the way the jobs involved are learned. Agricultural, engineering, commerce, catering, and hotel trade colleges must adjust to the new international fact of life. Unions, professional organizations, advertising agencies, and the media must also each mull their strategies. Last but by no means least, the ball is in the court of political decision makers, since they can no longer settle for simply following the trend. Once again, there is no avoiding globalization. It is neither good nor bad in itself, but it is up to the present generation to shoulder its responsibilities and make the most of it.

Consumers must also exercise their free will more effectively, thereby seeking to obtain full, reliable information and deciding on purchases based on their real needs (both material and cultural) and, of course, their financial resources. Quality does not mean luxury, but it takes a little effort to find it. There is no doubt that a pack of flaked or frozen potato purée costs considerably more than home-made. One may object, however, that working adults lack the time to cook at home. Nevertheless, the Chinese, who put in a far greater number of working hours than Europeans or Americans, largely continue to cook supper at home after shopping on the way back from work. Culinary culture remains a deep-rooted assertion of identity in China.

Why should this not be so in a country like France, which is only too happy to place it on proud display?

Reassertion of choice by consumers also implies paying special attention to children's food. The enologist and taste specialist Jacques Puisais and childhood psychologist Matty Chiva frequently recount the anecdote of a mother coming to tell them at the end of a talk about taste that her daughters ate nothing. They asked her if she herself did the cooking. "Never," came the answer, "I have no time and I hate it!" They had no small difficulty in getting her to understand that this was where the problem lay.

In addition to home cooking, the education system must of course fully perform its role, by teaching and via the quality of food served in school and university canteens. The effort required is just as great in hospitals or, even more so, in prison catering. The record is patchier in workplaces and down-market private catering.

Involving producer unions, chambers of agriculture, and local authorities cannot but help this drive to succeed. For instance, given the disturbing increase of alcoholism among youth, should public authorities not be involving them? Should these authorities not be enlisting young wine growers to explain to high school and higher education students how to take intense pleasure in drinking wine reasonably instead of "binge-drinking," rather than merely issuing bans and meting out punishments? The same goes for bread; the young can be taught to enjoy it instead of being left to gorge on industrial pastries and confectionery.

2.8 French Cuisine for UNESCO Intangible Cultural Heritage

The French government decided in 2008 that France would lodge an application with the United Nations Educational, Scientific and Cultural Organization (UNESCO) to have its culinary heritage included on the *representative list of the intangible cultural heritage of mankind*. The case file is not limited to luxury produce and *haute cuisine*. It covers all foods derived from farming, livestock raising, hunting and fishing. It also includes production and preserving techniques, culinary methods, skills bound up with gastronomy, consumption habits, ways of speaking and writing on the subject, social practices, and the ritual and festive events that feature them. These represent everything that makes ways of eating and drinking not just a means of maintaining strength and health, but a source of pleasure, an invitation to share, and a source of moral and spiritual enrichment; in brief, a culture. UNESCO delivered its certification to "*Le repas gastronomique des Français*" in November 2010. Since that time, several actions are in work in the fields of research, education, exhibition, and a great project is in preparation. This is creation of a "*Cité de la gastronomie,*" an international top place attractive to all kinds of public, of all ages, which is devoted to presentation and promotion of gastronomic heritage, know-how and food quality.

French traditions aside, all countries should be proud of their heritage and eager to develop and share it with the world. It is good that some countries had UNESCO

recognition of their entire diet or a special dish. These include Mexico, Morocco, Spain, Italy, Greece, Croatia and, probably in the near future, Japan. Every society possesses an incomparable culinary heritage linked to specific rituals that constitute its gastronomy, in the sense of the art of good eating and drinking, in full harmony with its values and with itself. The legitimacy of the French entitlement lies in the national concern to convert it into a part of learned and popular culture, to invent myriad links between daily life of the lower classes and the cuisine and wines of the pampered and educated. France and many other countries must engage in a crusade for food quality, not to preen but to take all countries, rich and poor, in tow, to reconcile mankind with its plate and glass.

3 The Clash of Civilizations is Not Inevitable

Civil and boundary wars are still numerous, and too many countries are not yet on the path of sustainable development. Peace is permanently threatened, even if international organizations try to avoid conflicts. Here, we may cite Islamic terrorism, survival of dictatorships of various styles in North Korea, Myanmar, Iran, Syria and other countries, and corruptive effects of civil wars in many countries. Cambodian, Rwandan or Bosnian genocides are not ancient. Outlaw territories are many in Africa, afflicted by horrible ethnic massacres involving children. Unfortunately, this has persisted from prehistory. Individual and collective human liberty may be equally oriented toward the common good and human welfare, or toward materialism, will to power, vanity, pride and rapacity. Hatred, bloodshed, and corruption are often linked to communitarian ideologies that spring from ignorance, preconceived ideas, or dangerous illusions about a "brave new world" promising paradise on earth. The expression "clash of civilizations," invented by Samuel Huntington in 1996, is inappropriate. It is in reality a screen masking selfishness, self-satisfaction and mutual ignorance, along with their terrible consequences.

This is why it is possible to say that geographic ignorance is a terrible weapon of mass destruction. First, it creates the idea that mankind has no power over the environment. This reminds one of the old millenarianist fears defeated by all civilizations since the Neolithic Revolution of 12,000 years ago, just after the last ice age. Then, it was common to be suspicious about different or ignored people. Institutionalized racism is the most hideous face of this closed attitude, but it is rooted in schoolchild attitudes. This is why education toward understanding and respecting of differences is necessary. Every person and social group can breed and express contempt, hate and violence. However, history teaches that conquests based on feelings of superiority and strength, without moral values and generosity, are dangerous and typically end in dramatic fashion, via revolution or war. The French poet Paul Valery wrote that civilizations are mortal. He was wrong; only barberries are mortal and fatal. On the contrary, civilizations live, change, transmit values, and progress.

The vicious cycle ending in mankind's self-destruction is very well known. It is necessary to think of a virtuous cycle, leading to prosperity, general welfare, social

harmony, optimism and hope. There is no ideal and universal model for all, at all latitudes. Those who believed this created the most terrible tyrannies and provoked innumerable deaths. In contrast, civilizations are always born from knowledge, love, education, social management, responsibility, and belief. It is evident that less alphabetized and educated countries are the poorest, where infant mortality and unemployment rates are highest and life expectancy shortest. These countries are also less democratic and politically unstable, the most afflicted by civil or ethnic wars (Africa), and most corrupt (Latin America).

Social control is an interesting concept, developed by the French geographer Pierre Gourou who worked for many years in Southeast Asia.[3] It may be applied to family, local organizations, companies, and the state. Such supervised structures are based on law, guarantees of justice, moral strictness and honesty, encouraging anyone to act and express by renouncing oneself. Some people think that such ideals are noble, but total utopia or simplicity. Nevertheless, these ideas are major foundations of great civilizations, particularly in Eurasia. Now, let us look at examples from China and the Mediterranean area.

3.1 Confucian Wisdom and Asian Civilizations

The following is from the Confucian *Analects*, which have informed Chinese and Far East cultures. The first aphorism is a good abstract of the Master's philosophy (I,1): "Isn't it joyful to study, then, when the time comes, to put into practice the learned knowledge? Isn't it happiness to have friends coming from far away? Is the honest man living unknown unhappy?" To the question "What to do in order to make the people respectful, fair and zealous?", Confucius answered (II, 20): "Treat him with dignity and he will be respectful; try to be a good son and good father, and he will be fair; promote talented men, educate the inefficient people and you will stimulate his zeal." Regarding modesty necessary for peace, it is useful to meditate on this remark filled with sense of humor (VII, 31): "I'm lucky: when I make a mistake, there's always somebody to look at it!" Respect of good behavior is not slavery and allows *modus Vivendi* (VIII, 2): "A politeness which is not moderated by ritual is tedious; caution not moderated by ritual is frightened; courage not moderated by ritual is violent; frankness not moderated by ritual is hurtful." Confucius also believed strongly in exemplifying strength to promote progress (IX, 14): "Master wanted to emigrate towards barbarian countries. He is told 'How could you accept wildlife?' Master answers 'Where is honest man, wildness disappears.'" And when he was asked the supreme virtue and major knowledge (XII, 21), he answered: "Love our neighbors…know others." Last, good politics needs time to bear fruit, and Confucius gave an abstract of his thought (XIII, 11): "When good people govern for one century, it becomes possible to remove cruelty and murders".

[3] See for instance Gourou (1982).

3.2 Near-East and Mediterranean Ways

The culture of the Far East has given priority to groups and sociability rather than to individual expression. This is not so in Near-East and Mediterranean civilizations. Ego, personal adventure, heroism and holiness are exalted, but manifests in self-sacrifice, respect for others and compassion. However, differences are not so great; civilizations are joining in universal wisdom. Was Socrates so different from his near-contemporary Confucius, when he proclaimed[4] "Virtues do not come from wealth, but wealth comes from virtue, both for persons and for the state." Is not the famous admonition "know thyself," from the Delphi oracle and repeated by Socrates, common to all advanced cultures?

Five centuries later, Jesus' message was similar to the wisdom of these two famous philosophers, expressed by the most important commandment[5]: "Love thy neighbor as thyself." Out of religious faith, many parables (of the sewer, talents, good Samaritan, faithful servant, bad rich, and others) and Christian thought are related to a sense of effort, honesty, generosity, justice, love, and others. Even political governance was evoked by Jesus,[6] with words very similar to those of Confucius or Socrates: "Those who are considered as heads of nations and want to affirm strongly their power are not so respected. Among you, it must be different: those who want to be powerful must be your servant, and those who want to be the very first will first became your slave".

Concerning secularity, a necessary rule for harmonious common life given the present diversity of faiths or unbelief in the world, let us remember this famous saying of Christ[7]: "Give to Caesar what belongs to Caesar and to God what belongs to God." This is one of the most important conditions for cultural dialog between peoples and cultures.

3.3 Good use of Globalization

The persistence and progress of a civilization depends on its writing capability, the only sustainable means for preserving knowledge, apart from approximate oral transmission. The famous sentence of Amadou Hampâté Bâ, a Malian writer, is terrible: "An old man dying is like a library burning!" This is in fact a directive for development and peace in Africa, where it is urgent to open libraries and promote education for all, since old men must of necessity die! Solidarity and generosity are wonderful qualities of African societies, but they are too often stopgaps in the face of poverty, anarchy, corruption and general carelessness.

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[4] Plato, The Apology.

[5] Mt, 22, 39; Mc, 12, 31; Lc, 10, 27; Jn, 13, 34–35.

[6] Mt, 20, 24–28; Mc, 10, 41–45; Lc, 22, 25–27.

[7] Lc, 20, 20–26; Mt, 22, 15–22; Mc, 12, 13–17.

Values allowing humanity to move toward peace and welfare have been known for a long time. Not a single moment of human history has been exempt from suffering, misfortune, and injustice. However, some periods have been beautiful successes in certain lands, albeit with problems. These periods have usually been characterized as civilizations—Athens in the fifth century BC, three centuries of *Pax romana*, Tang's China, tenth century Andalucia, *Quattrocento* Italian cities, and others. Therefore, why be desperate about the present? Why believe in the end of history and inevitable clash of civilizations? Let us admit no fatalism, no direction to history, contrary to the deadly Marxist belief. Tomorrow will be what we decide.

Instead of criticizing international organizations that are sometimes bureaucratic, costly, hesitant and helpless, it would be better to decide that they are useful and in need of good management and function. Let us improve the United Nations and specialized agencies such as UNESCO, G8, G20, EU, MERCOSUR, ASEAN, International Olympic Committee, international scientific unions like the International Geophysical Union, World Conference of Religions for Peace, international exhibitions, festivals (cinema, art, sciences, trade and others), Davos World Economic Forum, and many others. Their existence and their influence are objectively useful, because they involve meetings, dialog, and negotiations, which is better than isolation, rivalries, insults, quarrels, and conflicts. The same applies to multicultural firms, which are excellent institutions for dialog.

If we do not wish a return to the law of the strongest, we are obliged to live together and seek cooperation and common projects. This is the only way to take advantage of globalization. Even if we are critical in some ways about them, all these organizations of dialog tend toward political, social, economic or cultural progress. They need freedom and peace, and are generally going in a direction toward more real democracy, more enlightened world governance, and more effective environmental management.

This is why geographers must believe in mankind. They are deeply curious and admiring of global diversity. Their eminent vocation is the facilitation of cultural dialog. The worst outcome is never certain. Hopeful, reasonable optimism and continuing effort is our duty and our good fate. There is a happy use for globalization.

4 Conclusion

Pessimistic diagnosis of the global situation and forecasts of the future collapse of humanity are completely inconsistent with the tremendous technical progress of the last few centuries, especially recent decades. Such desperate viewpoints are signs of moral hopelessness. Fortunately, such feelings are not general. They are typical of old, developed countries wearied by hard efforts toward progress, and increasingly lacking in values and philosophical and moral ideals. "Nature" and resources were made for mankind and not the reverse. Enlightened governance is the only solution. It is a sign of real decadence when one thinks, as Denis de Rougemont wrote, "What will happen tomorrow?" instead of "What can I do?" John F. Kennedy was expressing

the same idea in his inaugural address of January 20, 1961: “Ask not what your country can do for you; ask what you can do for your country.” This famous quote, addressed to the American people, is applicable to the present age and its people. People in emerging and even very poor countries are generally more optimistic, dynamic, energetic, and imaginative than in wealthy ones. It is one of the missions of the geographer and social scientist to explain this and invite everyone to be realistic and active. The sky will not fall, but a pleasant future depends on human cleverness and wisdom. This has always been the case, even during the worst periods of human history.

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Biodiversity, Native Domestic Animals, and Livelihood in Monsoon Asia: Pig Pastoralism in the Bengal Delta of Bangladesh

Kazunobu Ikeya

Abstract Geographers study our interactions with other living creatures. Here, life can be classed into three categories by the degree of human-creature interaction: wild animals and plants; domestic animals and cultivated plants bred for food; and pets and houseplants, kept for cultural reasons. We have to find ways to live with creatures and maintain earth's biodiversity. Modern society often promotes the protection of wild animals and plants and wilderness biodiversity, but neglects the diversity of indigenous domestic animals. Some localized domestic animals are faced with extinction. Should we maintain the genetic and cultural diversity of domestic animals? The cultural and biological diversity of farm animals from dry lands is well documented, but little attention has been paid to domestic animals from wet environments; for example, Monsoon Asia. For this reason, I chose to study pig farming in the Bengal delta of Bangladesh. Pig farming in this area uses the natural resources of the delta and local breeds of pigs in a nomadic pastoral farming system. The results of my study illustrate the use and management of farm animals in a complex environment, and increase our understanding of human-farm-animal interaction and the 'geography of creature cultures'. The study provides lessons for the future of our culture and civilization.

Keywords Bengal delta • Creature cultures • Feed resources • Herd management • Native domestic animal • Pastoralism • Pig

K. Ikeya (✉)
National Museum of Ethnology, Senri Expo Park 10-1, Suita, Osaka, Japan
e-mail: ikeya@idc.minpaku.ac.jp

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1 Biodiversity of Earth and a 'Geography for the Interactions of Human and Animals'

Homo sapiens first left Africa approximately 70 thousand years ago and spread throughout the earth. Our first interactions with animals and plants were through hunting and collection, and we sometimes wiped out entire species. However, our relationship with other creatures changed as humans learned to cultivate, domesticate, and develop animals and plants for our own use, thus developing the relationship or interactions of human and animals.

Even now, that culture and our relationship with the natural world continue to change. Recent developments include transgenic corn and cloned sheep. Our close contact with domestic animals may infect us with new diseases such as influenza, and animal diseases affect our farming and economy. In 2010, more than 200,000 domestic animals were killed in Miyazaki, Japan, because of an outbreak of foot-and-mouth disease. Despite farmers' best efforts, crops in the farming and mountain villages of Japan are still damaged by wild boar, deer, bear and monkeys has become a severe issue, the problem has remained unresolved (Takahashi 2006; Ikeya ed. 2008).

Geography seeks to understand human interactions with other creatures (Ikeya ed. 2013). Humans need to live with creatures and maintain earth's biodiversity. Robbins et al. (2010) divided our interactions with other creatures into three categories: wild animals and plants, domestic animals and cultivated plants bred for food or other commercial reasons, and pets and houseplants kept for cultural reasons. The way our knowledge, techniques, business, livelihood, art, and faith interact with living creatures can be defined as a "creature culture" (Ikeya ed. 2013). We can also divide human-creature relationships into three approaches: biogeography (observing humans from the view of creatures); human geography (understanding creatures from the view of humans); and integrated geography (examining the interaction of nature and humans).

Modern society promotes the protection of individual wildlife species and biodiversity in particular areas. Here in Japan, we often feel strongly that wild animals like *Toki* (crested ibis), storks, Iriomote wild cats, and dugongs should be protected, but our feelings about conventional farm and domestic animals are different. In many places, conventional domestic animals are also faced with extinction. Modern science can change the biological properties of domestic animals. Although our ability to change creatures may originate from our view of domestic animals as fillets of flesh rather than creatures, should we not also maintain the genetic and cultural diversity of domestic animals?

Most geographical and cultural anthropological studies of livestock farming have focused on stock farmers in dry land and in high mountains in Afro-Eurasia (Ehlers and Kreutzmann 2000; Janzen and Bazargur 2003; Watanabe 2006; Butt et al. 2009; Kreutzmann 2012). These studies examined the relationship of human beings and domestic mammals belonging to gregarious Ungulata, such as cows, horses, sheep, goats, camels, yaks, and reindeer. Well-known techniques of domestic

herd management include isolation of mother and child, male castration, and pasturage. However, none of these techniques are applicable to pigs. Although pigs (*Sus scrofa domesticus)* belong to the Ungulata class, pigs are only gregarious in the wild.

Rappaport (1968) studied pig grazing, rearing, and confinement by farmers in Papua New Guinea. Nakai (2008, 2009) reported on pig farming in northern Thailand and Albarella et al. (2007) discusses historical interactions of pigs and humans. These studies address cultural history, feed resources, breeding techniques, livelihood activity, money economy, and the ceremonial uses of pigs. Usually, domestic pigs are managed in feed lots, confined to cages, or by fencing.

Few authors have investigated pig nomadism, where stockmen move a herd of pigs to different pastures throughout the year. I studied pig nomadism and pig farming in the Bengal Delta of northwestern Bangladesh (Ikeya et al. 2010b), from the viewpoint of environmental geography. This area is part of Monsoon Asia. Information from the study will help protect the diversity of conventional domestic animals, and I also wish to discuss the use of earth space and the relationship of humans with other animals. I began direct observations in December 2007 and made ten short visits to Bangladesh. On each visit, I looked for herds of pigs. I recorded production activity of nomadic pig farmers, breeding practices, herd movements, and the age and sex compositions of the herds. In August 2008 (wet season) and April 2009 (dry season), I visited breeding herds dispersed through the Bengal delta at the end of the season and I recorded the campground location, numbers of pigs bred and the attendant stockmen. At the end of April, 2009, I recorded herds of sows and piglets and estimated piglet survival.

2 Domestic Animals and People in Monsoon Asia and Japan

2.1 Regional Diversity

Most domestic animals, except for alpaca (South America) and donkey (Africa), were originally tamed in Asia; goats, sheep, cows, pigs, and camels were all domesticated in western Asia; chickens, pigs, and water buffalo were domesticated in southeastern Asia (Ikeya et al. 2010a); and horses and yaks in central Asia. From a global perspective, the richness of native domestic animals (sheep, goats, cows, water buffalos, horses, camels, pigs, fowl, ducks, bees, and elephants) is highest in Asia (Fig. 1) (Masuno 2008, 2012).

Some aspects of the relationship between domestic animals and the ethos of livestock farming in the Asian grassy plain and desert in areas such as Mongolia, the Arabian Peninsula, and northeastern India are known, but less is known about the cultural views of domestic animals in wet areas of Asia, such as Bangladesh and Thailand. This may show people's contempt for domestic animals, or that, in Monsoon Asia, more emphasis is given to paddy rice growing (Asada 2012).

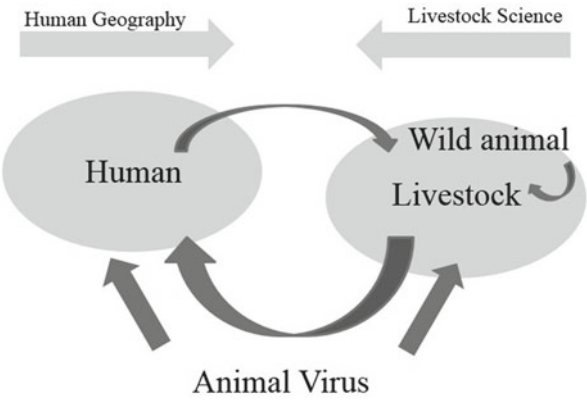

Fig. 1 Human–animal interactions

Although many people may believe domestic animals are not bred in monsoon areas, Asian markets sell live fowl, pork, hen and duck eggs, and water buffalos and cows are displayed. Pigs are even farmed in Bangladesh, where Muslims, who are forbidden to eat pork, account for about 90 % of the population. Farmers breed ducks in the suburbs of Hanoi, the capital of Vietnam. In the mountain villages of Thailand and Laos, wild fowl and domesticated roosters are still raised in hills behind the villages (Sirindhorn and Akishinonomiya 2010). Although wild fowl interbreed with domesticated chickens, they differ from domestic fowl, have a distinct cry, and are startled by the presence of people (Ikeya et al. 2010a).

Small-scale animal farming is a crucial part of traditional village economies. Wild boars are bred in several Asian countries including Japan, Thailand, and the Philippines. In some villages, young wild boars are captured and fed in captivity. Alternatively, a herd of wild boar may be encouraged to eat discarded fruit in gardens. Other people breed wild boars to sell the meat, but their management is unstable. Except for mountain zones of southeast and southern Asia, fowl or cattle or water buffalo are also indispensable for ritual sacrifices. Cockfights are quite popular and domestic animals are an important protein source for the cocks' nutrition. In these villages, people retain their traditional commitment to domestic animals.

In the past, domestic animals were fed from local resources, such as the bark of wild and cultivated bananas (Nakai 2009). As such, animals were allowed to graze freely on local farms. However, large-scale livestock breeding and farming by commercial enterprises under professional management is spreading in many Asian countries. Animals are confined at high-density and may be fed artificial diets using imported feeds, such as corn from China. Consequently, environmental effects on domestic animals have increased; for example, epidemics of influenza badly damaged stocks across Asia.

Industrial farming is well developed in modern Japan, where the relationship between domestic animals and people is now constrained by corporate livestock management. Special breeds, such as Japanese black cattle or black pigs, were

developed to supply demand for ‘marbled meat’. Cattle breeders in Miyazaki prefecture send calves to Kobe and Matsuzaka, to be raised in cosseted environments, which even include beer and massage.

Industrial farming creates new risks. In 2010, more than 200,000 cows were killed in Miyazaki prefecture by an epidemic of foot-and-mouth disease (Miyazaki-nichinichi Shinbun Company 2011). One of these cattle was a prize bull that had sired 190,000 calves, which generated ¥3 billion (about US$30 million) for the owners.

In this way, the relationship of humans with domestic animals has changed. The regionally diverse interaction of Asian people with domestic animals produced a rich variety of breeds, and the breeding and feeding systems reflected local people’s commitment to their animals. We cannot ignore the way in which industrial agriculture, rationalization, and modernization of the Japanese stockbreeding industry has changed our view of domestic animals.

2.2 Native and Introduced Domestic Animals

Different Asian communities have ‘improved breeds’ that are regarded as native species. For example, the half-wild cows called ‘Gayal’ or ‘Mithan’, from Bhutan and Bangladesh, move freely through the mountains but can be lured close to settlements with salt. Among the minority ethnic groups living in the Chittagong hills near the Bangladesh border with Myanmar, these animals are killed in ritual sacrifices. The Gayal population is endangered as forests are felled and fewer than a thousand now exist. In the mountain regions of Thailand and Laos, native pigs and fowl are ritually killed. Few farmers now breed the ‘Dontag’, a unique large-legged cock formerly found in villages and the suburbs of Hanoi, Vietnam. Many Japanese native domestic animals, including Kiso, Yonakuni, and Tsushima horses, Tokara ponies and Tokara goats are also endangered.

Black pigs, called ‘Agu’ or ‘Ayo’, from Okinawa are being commercialized because the meat is regarded as dainty. Although pork is indispensable for Okinawa celebrations, such as the New Year holidays, people seldom take Agu pigs (Shinjou 2010). The relationship of people with native domestic animals has changed because the livelihood of local residents was separated from domestic animals. I also note, as in many other parts of the world, local breeds have decreased, and introduced global breeds have increased. There are commercial reasons behind these changes; for example, the Okinawa Agu has 14 vertebrae, while the global ‘Landrace’ pig breed has 22. Thus, the Landrace breed produces more meat. European and American breeds have displaced less productive native domestic animals, even if the latter are more resistant to disease or can survive on plain food. Farming monoculture is economically efficient and is characteristic of modern civilization. However, intensive breeding for meat and growth may have reduced resistance to disease and helped cause the outbreak of swine influenza in 2009.

3 Pig Nomadism in the Bengal Delta

3.1 General Outline of the Study Region

I chose the Bengal Delta of Bangladesh to study the management of local varieties of pigs. The study area was close to the junction of the Ganges and the Brahmaputra Rivers. The Ganges flows from the Himalayas, through the northern plains of India and joins the Brahmaputra River in Bangladesh. The Brahmaputra flows from the Chinese Tibetan plateau via Assam (Fig. 2). The study area was a few square kilometers, and extends over Tangail-, Gazipul- and Dhaka Zilas (districts). It was difficult to find stockmen's camp as they moved their herds constantly.

Although the annual domestic animal census by the Bangladesh government counts cattle, water buffaloes, goats, sheep, fowl, and ducks, the census omits pigs. Most Bangladeshis are Muslim and despise pigs, and the people may consider it disrespectful to count pigs. Despite this dislike, pigs are raised in Bangladesh

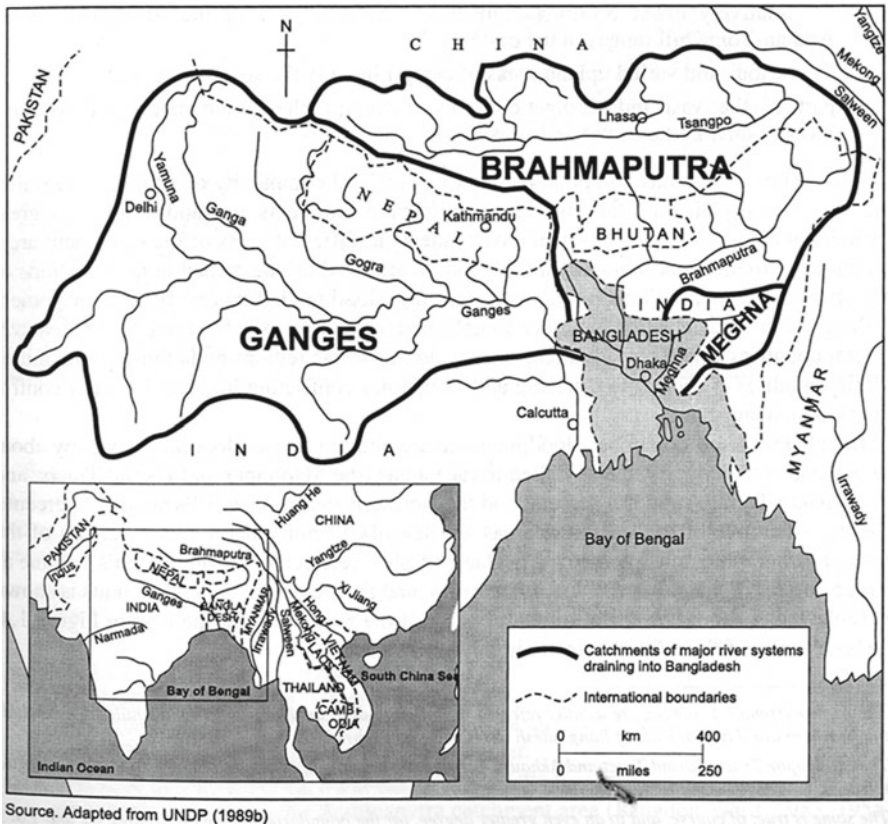

Fig. 2 Study area

Fig. 3 Native pigs called "wild boar type" in Bangladesh

(Singha and Reza 2005). The climate of the study region is monsoon tropical, characterized by two seasons; a flood season during June–September and a dry season from October to April. The wet season usually begins around June, and rivers overflow in August reducing the land area available for grazing. The river levels fall in October, and the land drains. Local domestic pigs are black (Fig. 3), slender with a protruding nose, a characteristically long mane, and closely resemble wild boar (*Sus scrofa*). However, it is a species of domestic pig (*Sus scrofa domesticus*). The size varies with age: adult height is 48.8–52.8 cm, but no data on length or adult weight are available. Geneticists call this variety a 'wild boar type' and it is one of the most primitive domestic pigs still found on the Eurasian continent (Kurosawa 1995). Although it would be interesting to discover why this type of pig exists in the Bengal delta, this report is confined to a description and analysis of the status of pig nomadism.

3.2 Management of Livestock Farming of Native Pigs

We do not know how many households own and breed pigs, but pigs owned per household vary from a few dozen to more than one thousand. I investigated nomadism by following the herds of a 'large-scale operator' who owned 800–1000 pigs.

3.2.1 Form of Breeding

This owner owned 812 pigs in 2008 and 1,159 pigs by the end of April, 2009 (dry season; Tables 1 and 2). At the end of August (wet season), 2008, the owner

Table 1 Grazing land, number of herder, pigs number (August 2008)

Pig group	Grazing land	Number of herder	Pigs number
1	Arasin, Tangail	6	218
2	Torabganj, Tangail	Unclear	113
3	Gobalpur, Tangail	5	143
4	Kannavar, Tangail	9	128
5, 6	Unclear	9	210
Total		29	812

Source: Author participant observation

Table 2 Grazing land, number of herder, pigs number (April 2009)

Pig group	Grazing land	Number of herder	Pigs number
1	Borobari, Gazipur	2	28
2	Konabari, Gazipur	3	80
3	Kaliakoir, Gazipur	5	149
4	Kaliakoir, Gazipur	5	145
5	Kormejyuni, Tangail	4	142
6	Joinpur, Tangail	5	217
7	Jobra, Tangail	6	226
8	Dholpur, Tangail	6	172
Total		36	1,159

Source: Author participant observation

was breeding six dispersed herds of pigs centered at Tangail Zila, some 100 km north of Dhaka. I found 218 head were bred at Arashin, 113 at Torabganj, 143 at Gopalpur, 128 at Kannavar in the Zila, and 210 in two other places. The owner bought all pigs bred at Torabganj from another breeder living close by.

In the April 2009 dry season, the owner bred eight dispersed herds of pigs: eight herds of 28 head in Borobari, 80 in Konabari, 294 in Kaliakoir, Gazipur Zila close to Dhaka, 142 in Kormejyuni, 217 in Joinpur, 226 in Jobra, and 172 in Dholpur, Tangail Zila. The total number of pigs and herds differs from season to season. There were 812 head in six herds in the wet season at the end of August and 1,146 head in eight herds in the dry season at the end of April. A minimum of two and a maximum of nine stockmen managed each herd, but most herds were managed by four to six stockmen. In the dry season, herd campsites included two garbage dumps near Dhaka. The dumps were close to the slaughterhouse and convenient to supply Dhaka, a place of great consumption.

3.2.2 Workforce for Livestock Farming

The 2005 population of Bangladesh was 140 million (WHO 2005) and the 2001 national census found 89.7 % were Muslim, 9.2 % Hindu, 0.7 % Buddhist and 0.3 % Christian. Muslims and many higher caste Hindus despise pigs, although lower caste Hindus engage in pig breeding. They often own and breed a few pigs in their own villages. Other ethnic groups or tribes who breed pigs include Christians, Mandi (Garo), Santal and Chakuma for food and for rituals such as weddings and funerals.

Between 2008 and 2010, most stockmen were low caste Hindu, from the Rangpur District in northwestern Bangladesh. Five stockmen managed one herd in April 2009, but all five had quit four months later. Sometimes stockmen moved to another owner for a higher salary. Sometimes they returned to their home village to work in their own household. Stockmen complained that nomadism was hard work for low pay, several hundred kilometers from their home village. Although a 'large-scale proprietary' pig owner controls nomadic activity, he is not a nomad. Only men engage in nomadic work; women feed and look after the pigs in their home villages, but do not participate in nomadic herding.

4 Feed Resources for Pigs and Moving Behavior of Pig Herds

The key questions are why does pig nomadism occur in wet areas in tropical Asia, and why does it occur in the Bengal Delta, which is an area of high population density? We can answer these questions by considering the availability of feed resources for pigs, such as wild plants, and how herd movement is related to the distribution of feed resources.

4.1 Feed Resources as Natural Infrastructure

In the Bengal Delta, the ratio of dry to flooded areas changes greatly between wet and dry seasons. Although it changes from year to year, the land is made narrower by an overflow of rivers in the Wet season flooding reduces dry areas, and the timing of flooding changes from one area to another and from year to year. Many big and small branches of the Brahmaputra River exist in the study region, thus producing wide variations in the local environment.

Although the delta resembles a plain, the landscape is uneven on scales of a few meters, which produces a mosaic pattern as the land dries after the monsoon. Settlements are located on natural embankments and low lying land is cultivated for floating rice (Fig. 4). The higher land, (called bar, or 'Beel') supplies important pig grazing areas. The high population density and other agrarian activity also limit land availability, so post-harvest farmland and unused land between farmland and roads were also used for grazing.

Pigs eat many plants (Table 3). Some feed resources are seasonal, and other resources are available throughout the year. For example, 'Gechu', 'Shalik', and 'Kosteli' (water hyacinth) are seasonal wild plants and 'Kachu' and 'Vadali' are available throughout the year. Pigs also eat rice hulls left in post-harvest paddy fields; insects and earthworms may also be eaten in the dry season. 'Gechu' grows in fields after plowing (Fig. 5) and has slim green leaves up to 10 cm long. The local farmers regard this plant as a weed. 'Shalik' (Fig. 6) also grows in post-harvest fields. Both plants develop underground rhizomes that pigs eat after digging up the topsoil. 'Kosteli' are emergent aquatic plants that grow in post-harvest rice fields (Fig. 7), and the pigs eat the leaves for a limited period.

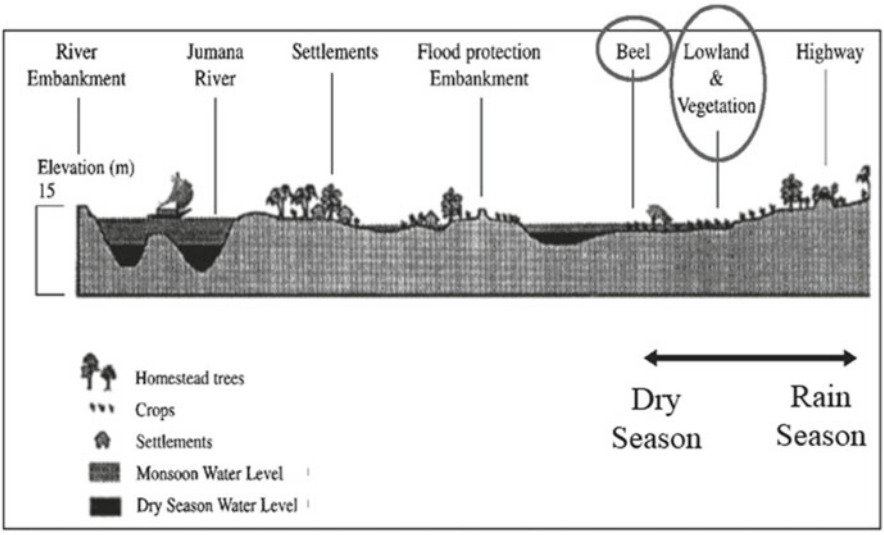

Fig. 4 Typical micro-landform in the Bengal Delta. *Source*: Ali et al. (2000)

Table 3 Main wild plant fed by nomadic pigs

Local name	English name	Family name	Plant name
Gechu	Floating lace plant	Aponogetonaceae	*Aponogeton natans*
Shalik	Water lily	Nymphaca stellata	*Nymphaca nouchali*
Kachu	Chinese taro	Araceae	*Alocasia cucullata Colocasia esculenta* (L.) Schott
Vadali, Mutha, Kenna	Nut grass	Cyperaceae	*Cyperus rotundus* L.

Source: Authors fieldwork (Ikeya and Faruque 2013)

The most important natural feed for pigs was 'Kachu' (Chinese taro, Fig. 8). This wild taro (Araceae) grows throughout the Bengal Delta. It is found along field ridges next to rice paddies, in unused strips along roadsides, and around the periphery of farm ponds. The rhizome of thisis plant is particularly important. The stolon runs along the ground just below the surface. Pigs eat most of the plant except for the stolon, but appear to eat more rhizome than leaves. The Taro rhizomes can grow up again regenerate from the stolon within 2–3 months when the original was eaten. Pigs also consume the rhizome of 'Vadali', also known as 'Mutha' or 'Kenna', (Fig. 9). Although this plant is not as common as taro, it grows in rice paddies or jute fields after harvests. Thus, most pig feed consists of wild plants, and the distribution and density of these plants are influenced by agriculture. Many farmers regard the plants as weeds so pigs provide a service by removing the weeds. The most important feed is 'Kachu' (wild taro); stockmen said that pigs prefer taro rhizomes to water hyacinth leaves, which float on water surfaces.

Fig. 5 The plant called *Gechu*

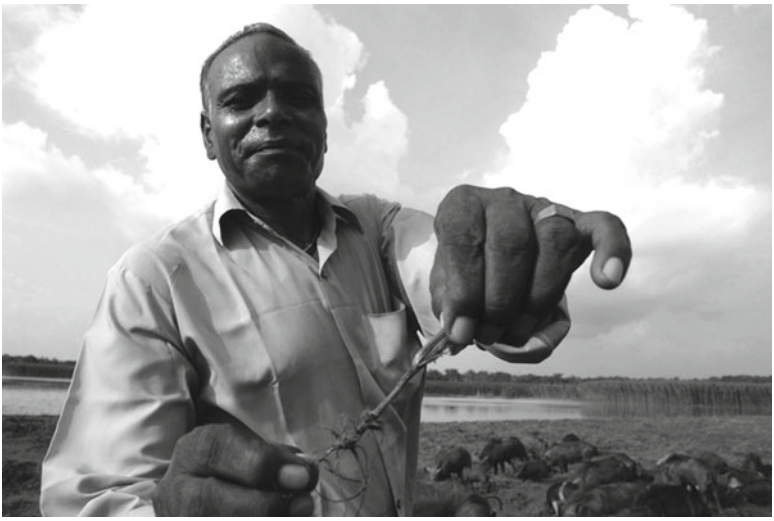

Fig. 6 The plant called *Shalik*

4.2 Daily Change of Herd Location

Herd location depends on the distribution and availability of feed. Feed distribution is influenced by several factors, including flooding in the wet season and the micro-topography of land. Between April 26 and May 2009, one herd with 35 sows and

Fig. 7 The Plant called *Kosteli* (Water hyacinth)

Fig. 8 The plant called *Kachu* (Chinese taro)

182 piglets 1.5 months old moved 5 km daily (Fig. 10), which a piglet could walk by itself. During five days of observation, I found that stockmen chose riverbanks under large bridges (Fig. 11) and land close to highways for campgrounds and grazing. Although the herd sometimes crossed roads in urban areas where Muslims were in the majority, no pig dropped out (Fig. 12). When piglets walked in the central part of the road, stockmen controlled traffic. People walking by sometimes covered their faces with cloths to ward off the smell.

Fig. 9 The plant called *Vadali*

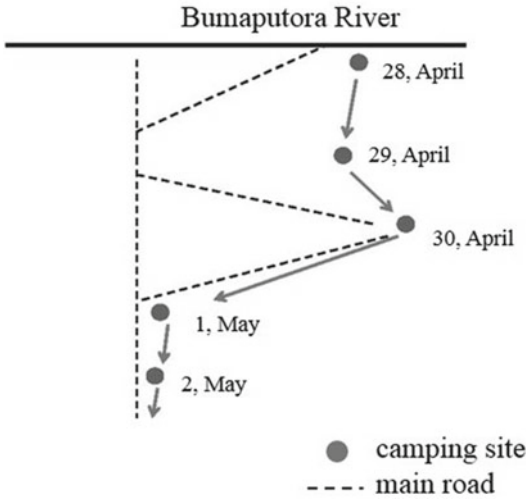

Fig. 10 Migration route of one pig group (2009). *Source*: Authors observation

On 2 May 2009, I plotted the movement of pig herds over 3 h (Fig. 10). From this campground, herds of pigs moved between grazing sites, stopping to feed on 'Kachu'. On one occasion, local Muslims ended the grazing after three minutes, although feeding duration at any one site was usually 8–11 min. During the observation period, piglets suckled four times, and suckling was instigated by the piglets

Fig. 11 Grazing area under the bridge

Fig. 12 Herders who go across inside the city

themselves, not by stockmen. Rubbish dumps along the city highways were grazed for several months (Fig. 13). There is a hutted camp built by two stockmen who cared for dozens of pigs. Garbage men brought rubbish to the dumps from the local neighborhood and pigs fed on raw garbage. Other people collected paper and

Fig. 13 Pig herds grazed in the dumping ground

empty cans for recycling from the same dumps. In Konabari, Gazipur Zila in the suburb of Dhaka, dumps spread along on both sides of a highway under a bridge. In February 2008, I found two pig herds with different owners and divided by a road, sharing limited resources at the dump sites. The stockman lost the option of grazing at the dumps when, in August 2008, the local government prohibited the grazing of dump sites for sanitary reasons and built a one meter fence between the dumps and the highway.

4.3 Seasonal Change of Herd Location

The 'large-scale owner' dispersed grazing herds to different sites through the four seasons from February 2008 to April 2009 (Fig. 14). Although I confirmed the locations marked on the map for the day I visited the campsite, the herd did not remain in one place between seasons (Fig. 15). In the dry season (February, 2008), I found three herds in Tangail Zila and one herd about 10 km from Dhaka at a rubbish dump in Gazipur ward where pigs can be slaughtered and the meat sold in central Dhaka. In the wet season (July, 2008) only one herd remained at Tangail Zila and two had moved to the Dhaka suburbs. The grazers used the same dump for two consecutive seasons. In the wet season (August, 2008) all herds were moved to Tangail Zila. I found no campsite in the Dhaka suburb rubbish dump. In the dry season (April, 2009) pig herds stayed in Tangail Zila and in Zila south of Tangail but one herd stayed at the Dhaka suburb dump site. This evidence shows that herders use 10–20 km^2 and move the herds continually between sites, although the movements were confined to Tangail and Dhaka Zilas.

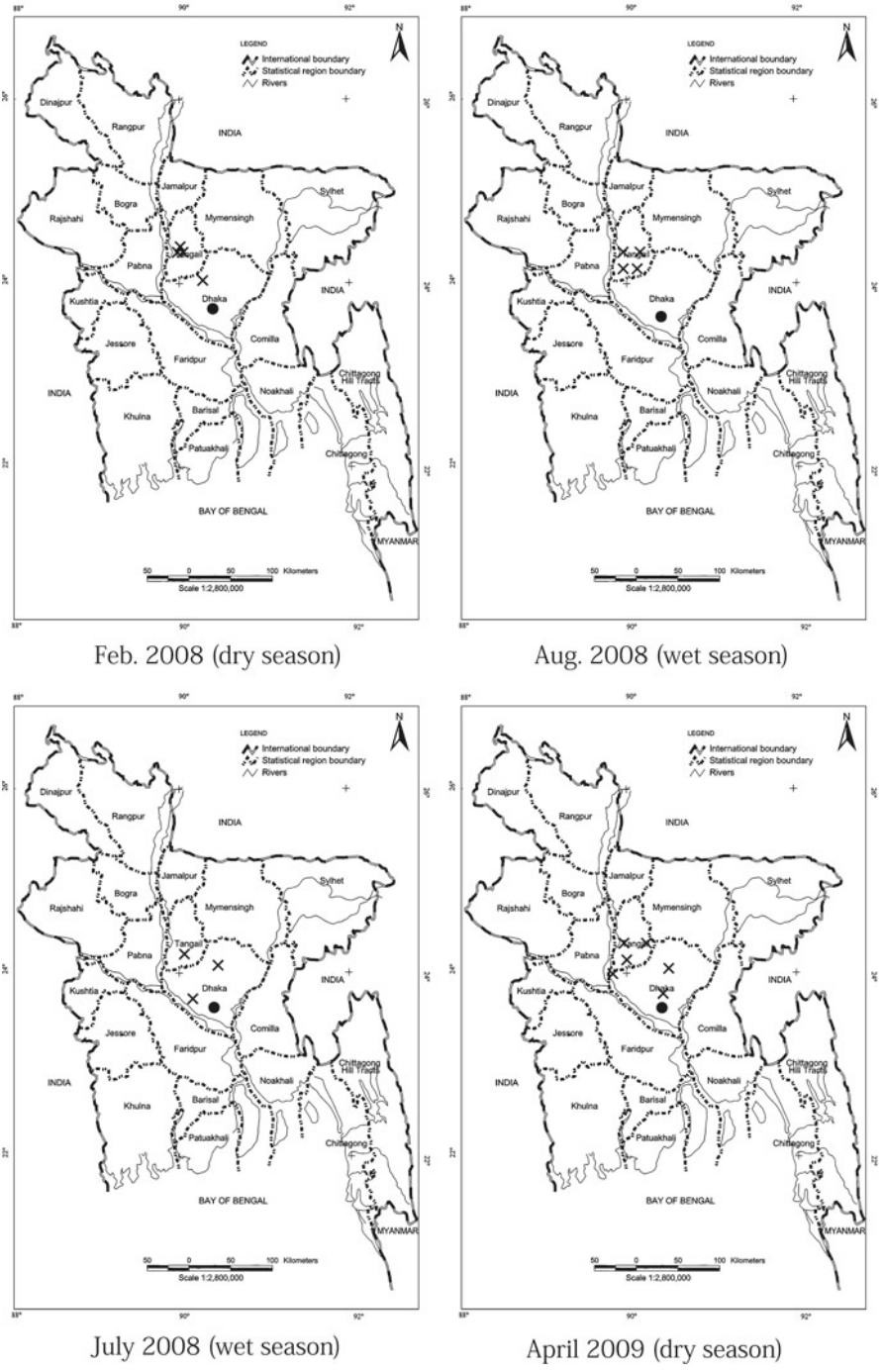

Fig. 14 The distribution of several camps of pig breeders. X shows the campsite

Fig. 15 The camping site of one-day grazing in the dry season

5 Reproduction of Pigs and Fluctuation

Nomadic pastoralism of pig herds needs an extensive land area and a workforce of stockmen. Stockmen must manage the entire herd and take care of single pigs. In the next section, I describe the management of grazing land and pig herds.

5.1 Typical Grazing Land

Pig owners do not have exclusive use of pasturage in this region and must graze private and public lands. The most common class of grazing is in farm fields, which may include rice paddies or dry fields, grazed after harvest. Several types of rice farming are practiced in this region. Aman rice is a floating variety cultivated in the wet season. Some rice paddies are irrigated in the dry season. Figure 16 shows pigs pastured in a post-harvest dry field next to a paddy field where rice planting was taking place. Unused public land such as riverbanks that dry in the dry season, slopes of roads constructed on a hill, and pond surroundings were also grazed (Fig. 17). It is said that the forest of Saul managed by the country might be used for grazing, although I have not confirmed that yet. Pigs eat roots of that tree when digging through soil in the forest.

Suburban rubbish dumps were used by several breeders. The pigs fed on discarded vegetables and fruit. This resource was more stable than other resources, although stockmen were excluded by local administrators managing the dumps.

Fig. 16 Pig grazing at the agricultural field after harvest

Fig. 17 The migration of pig herds along the road

The local government prohibited dumping of garbage at sites after the 2009 swine flu epidemic and stockmen lost grazing privileges.

In summary, pig owners have no right to monopolize land for grazing, and pigs were fed left-over rice chaff, or roots of wild plants. The majority of farm owners in Bangladesh are Muslim, and stockmen must control pig movements carefully (Fig. 18). Muslim farmers may not tolerate pigs and move the grazers on. However, disputes between stockmen and farmers over grazing appeared uncommon.

Fig. 18 Pig herding near the potato farm

5.2 Skill at Managing Herds of Pigs

What skills does a stockman use to manage pigs? I was not always certain whether the stockman followed the herd, or whether the pigs followed the stockman. Most herds were managed by three to four stockmen. One man carried about 10 kg of baggage, including a tent, pan, plate, and cooking utensils. This man walked behind the herd, and the whole team moved at least 5 km a day. The most difficult time for stockmen is the rainy season, which usually begins in June, because less land is available for grazing as floods spread. The stockmen chose campsites in unused land close to a riverbed or road after considering natural topography. The baggage carrier prepared two meals a day (morning and night) usually consisting of chapatti and rice, curry with vegetables and fish purchased from a local shop. The stockmen did not appear to slaughter or eat their own pigs. The men built a simple tent from sticks of bamboo a few meters long, bound to form a dome and covered with plastic sheets. Seats were spread over the ground.

When stockmen did not attend to grazing pigs, the pigs spread out seeking food. The animals were brought back into the herd by a stockman's calls. The pigs were addressed by unique shouts and hails such as 'HEREHERE', which induces the herd to advance. 'HOHN' means 'stop' and 'HIGH-HUHN' means 'come'. In contrast to the breeding herds, non-breeding herds consisted of 7–8 pigs depending on age, and each herd moved separately with a stockman searching for wild plants. Breeding herds included boars and sows with a high chance of fertility. Non-breeding herds were organized according to age irrespective of sex. Piglets less than 3–4 months old accompanied the sows during suckling. After five months, the mother pig was transferred to a different herd and the piglets remained with the non-breeding herd. Pigs of 8, 10, 12, and 14 months old were kept separate, and males were castrated

Fig. 19 Mother pig give the milk baby pigs

between 7–10 months. Pigs were moved to the city dump and slaughtered for consumption at the age of about 18 months. The breeding herd contained sows 1–5 years old, eight training males about 10 months old and about 20 other pigs up to 7 years old, producing a sex ratio of 3 to 1 sows to males. Sows did not become pregnant simultaneously. Stockmen divided the breeding herd when about half of the female pigs were pregnant and organized a new breeding herd. The gestation period of pigs is about 120 days. The owner divided the pigs into breeding and non-breeding herds by sex and age, and a skilled stockman took daily care of the pigs. Separate breeding herds are characteristic of the autonomous management of this type of nomadic livestock farming.

5.3 Birth and Death Rates

Fattening herds of nomadic pigs include suckling piglets, which asked for milk while the mother grazed (Fig. 19). Some mothers were reluctant to feed the piglets, and stockmen intervened by poking the sow's belly with sticks to induce the sow to lay down and allow the piglet to suckle. Five nipples are aligned in two lines on the belly of lactating sows, and in this breed, each piglet had its own nipple. One herd of 35 breeding sows included 182 piglets 1.5 months old. Three to ten piglets were delivered by each pregnancy (average 5.97, Fig. 20), but one sow could only nurse 4–6 piglets (Fig. 21). Surplus piglets were transferred to other sows or killed. When more than one pig was delivered in the same herd within a few days, stockmen evened the number of piglets per sow by transferring piglets between lactating sows. In this herd, stockmen exported nine and imported five piglets (Table 4); four piglets were

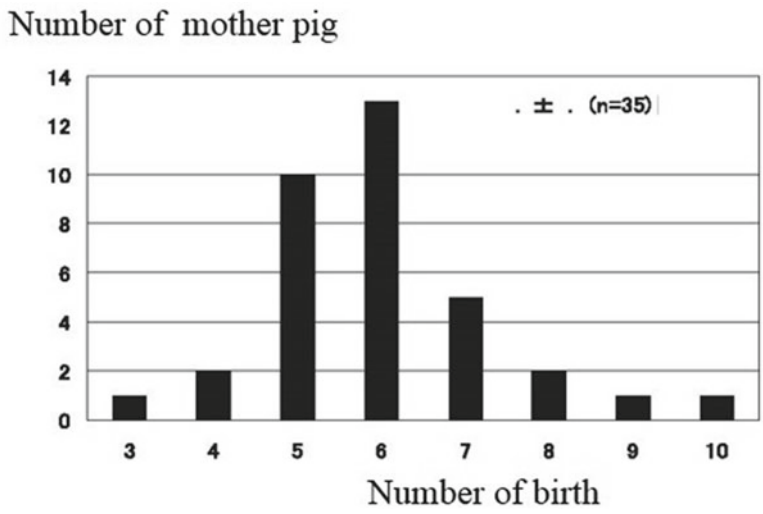

Fig. 20 The frequency distribution of the number of piglets. *Source*: Authors observation

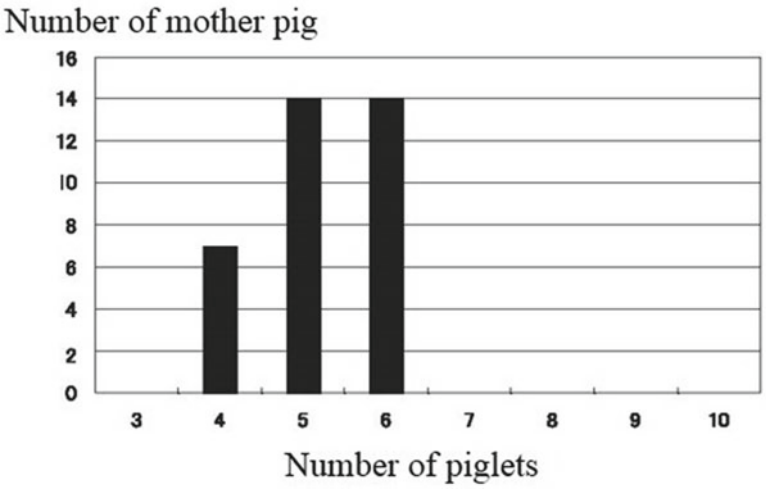

Fig. 21 The number of piglets milked by the mother per one mother. *Source*: Authors observation

unaccounted for. When six, seven, or ten piglets were delivered by one sow, a stockman killed one of each delivery. A stockman may kill two out of six, or three out of eight piglets. During observation, 15 piglets out of 209 piglets were confirmed killed (8.3 %); the cause of 12 deaths was not identified. Two were killed by foxes and one died of injury caused by a child. These observations indicate that stockmen try to even out the sow's lactation burden. The strategy of killing piglet soon after birth or exporting piglets to other mothers demonstrates an adaptive strategy arising from the dependence on wild plants in a severe environment.

Table 4 The number of piglets and transfer of piglets

①Number of mother pig	②Number of birth	③Number of pigs bred	④Import	⑤Export	⑥Killing	⑦Death	⑧Mortality	⑨Factors of death
1	6	6	0	0	0	0	0.0	
2	10	6	2	0	1	1	10.0	Fox
3	7	6	1	0	0	0	0.0	
4	6	6	0	0	0	0	0.0	
5	6	6	0	0	0	0	0.0	
6	4	4	0	0	0	0	0.0	
7	6	6	0	0	0	0	0.0	
8	5	5	0	0	0	0	0.0	
9	7	6	0	0	0	1	14.3	Fox
10	5	5	0	0	0	0	0.0	
11	5	6	0	0	0	0	0.0	
12	6	6	0	0	0	0	0.0	
13	6	6	0	0	0	0	0.0	
14	8	6	0	0	0	2	25.0	Unclear
15	5	5	0	0	0	0	0.0	
16	6	6	0	0	0	0	0.0	
17	6	4	0	0	0	2	33.3	Unclear
18	7	5	2	0	0	0	0.0	
19	6	6	0	0	0	0	0.0	
20	5	5	0	0	0	0	0.0	
21	7	6	0	0	0	1	14.3	Unclear
22	6	6	0	0	0	0	0.0	
23	5	4	0	0	0	1	20.0	Unclear
24	5	5	0	0	0	0	0.0	
25	5	5	0	0	0	0	0.0	
26	6	4	0	0	0	2	33.3	Unclear
27	6	4	0	0	2	0	0.0	
28	4	4	0	3	0	3	75.0	2 Unknown, 1 damaged by the child
29	6	5	0	0	1	0	0.0	
30	8	5	0	0	3	0	0.0	
31	9	5	4	0	0	0	0.0	
32	3	5	0	2	0	2	66.7	Unclear
33	7	4	0	0	1	0	0.0	
34	5	5	0	0	0	0	0.0	
35	5	5	0	0	0	0	0.0	
Total	209	182	9	5	8	15	291.9	
Average	5.97143	5.2					8.3	

Source: Authors participant observation and interview with herders

6 Pastoralism in the Deltas of Monsoon Asia

The operator described in this study owned about 1,000 pigs, distributed in breeding and non-breeding herds managed by 30–40 stockmen, and slaughtered to supply meat to Dhaka (Fig. 22). The owner maintained the herds by purchasing pigs from other growers. Past anthropological and geographical studies of pig breeding examined grazing in confined systems and did not consider pig nomadism, which still exists in the Bengal Delta. Pig herds are dispersed and moved through the delta, to provide for breeding and feed resources and require herd management skills to find nomadic pasturage and deliver pregnant sows. In particular, the breeders tried to even out the burden of mother sows by killing or transferring piglets after birth to different sows. This technique of nomadic pig breeding is probably an adaptive strategy to cope with distribution of wild plants in severe environments.

6.1 Productivity of Pig Breeding

About 5.9 piglets per litter were born in Bangladesh, compared to 10.5 in Japan, and 7.1 in Thailand (Table 5). However, the death rate (8.3 %) before weaning was lower than that reported from Japan (10 %), or Thailand (16 %), which compensates for the low productivity of nomadic pig pastoralism. Pigs grazed in dump sites and farmland, and nomadic pigs were never feed commercial feeds. At first sight, the Bengal Delta looks like a flat plain, but small differences in height greatly affect the

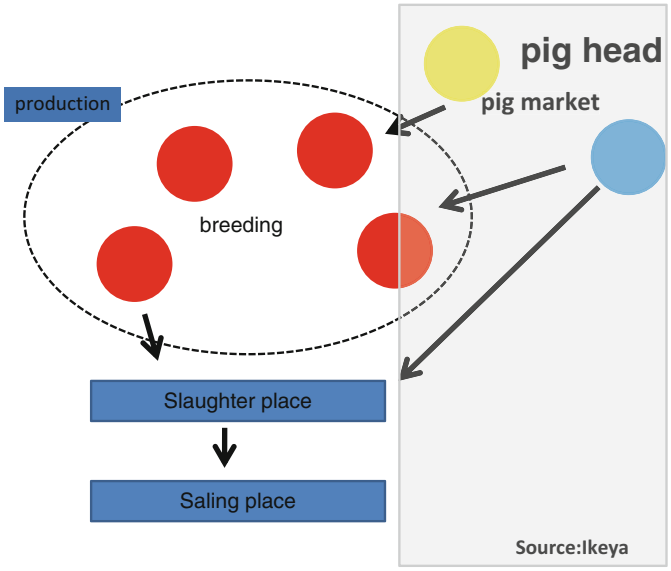

Fig. 22 Nomadic pig production system

Table 5 The comparison of the birth number and death rate in three countries

Birth number per delivery (head)	Death rate of before weaning (%)	Study area	Source
10.5	10	Japan	Livestock Dictionart editors (1996)
7.1	16	Thailand	Nakai (2008)
5.9	8.3	Bangladesh	Ikeya

Note: The figures in Japan shows the date planned by Ministry of Agriculture 1995 in Japan

grazing area during the wet season. Pigs cannot live in water deeper than the length of their legs but graze plants like water hyacinth that spread through shallow water. In addition, when people come to plow farmland and pigs lose their place to stay, they can move into post-harvest farmland. Pigs dig up and eat the roots of plants that farmers regard as weeds, and thus benefit farmers. Pigs also eat remnant rice grains after harvest. In areas growing wheat, corn, and jute, pigs may be moved to another place with the stockman. This form of nomadic pig pastoralism uses abundant nearly free feed, and mixed environmental resources that depend on the seasonal micro-topography of land. This enables dispersed farming of pigs in units of 100–200 head herds.

6.2 Comparison of Different Nomadic Pastoral Systems

Pig nomadism differs from other nomadic pastoral systems, such as camel nomadism by the Somali of Kenya (Ikeya 1998), the Raika of India (Robbins 2004; Ikeya 2005), and reindeer nomadism of the Chukchi (Ikeya 2001) of Russia in several key areas. All family members of the Somali nomads moved with the animals, which is typical of nomadic pastoralism. In contrast, the Raika nomads camel breeding herds all have their own village, where the nomads may stay, engage in irrigation farming, and breed water buffalo. In these villages, only the adult men in each family make seasonal movements with camels. The reindeer nomads of Chukchi follow the reindeer throughout the year—in this case, the nomadic pastoralism was operated as a Russian state farm. Reindeer nomads may have homes in permanent villages that differ from camps, but no home base. This form is called ‘production nomadism’.

The interaction between pastoral and crop farmers for cow breeding in the Fulbe (West Africa), and Raika (India) peoples has been studied. In both places, the annual destinations for nomadic herds are more or less fixed. The relationship between farmers and nomads is mutually beneficial because animal feces fertilize the crops and both parties profit from the arrangement. However, among the Fulbe, disputes between farmers and pastoralists were reported. I did not find a similar mutually beneficial relationship or dispute between the Bangladeshi pig breeders and farmers. The pig breeder does not get permission to use farmland as grazing land from the landowner, but some continued and fixed relationship must have been established between pig breeders and landowners.

Although the pig nomadic pastoralism in Bangladesh is not controlled by the state, it is similar to reindeer production nomadism in that the owner of the pigs lived in a city, but his pigs were always moving. This differs from Somali nomadism, where the entire family moves with the animals. Raika camel nomadism is administered exclusively by adult men. Another form of nomadism may also occur in Bangladesh, driving ducks and water buffalo, but this practice is not as common as nomadic pig pastoralism. Somali camels are bred for milk (Ikeya 1998), and female camels are needed. In contrast, Raika camels are bred for cargo carrying, and male camels are valued (Ikeya 2005). In comparison, pigs and reindeer pastoralism produce meat. Incidentally, the management skills required to control pig herds using sound are also used to control other livestock such as goats and sheep (Ikeya 1993).

7 Sustainable Co-existence in Global Space: Native Domestic Animals, Moving Creatures, and Commons

In the Introduction, I wrote that geographers try to understand the relation between animals and humans. Local studies must connect to a more comprehensive understanding of the whole earth. This study focuses on land used for breeding and examines a native domestic animal in the Bangladesh delta in Monsoon Asia. Does the use of space for livestock breeding differ in dry and wet areas? Janzen and Bazargur (2003) and Robbins (2004) describe livestock farming in dry lands, has been well documented (Janzen and Bazargur 2003; Robbins 2004), but livestock production in wet lands has received less attention. This may arise because many studies of tropical Monsoon Asia have focused on rice cultivation.

Sustainable common uses of resources may also occur in mountains, seas, open fields, forests, and parks in other areas of the earth (Giordano 2003). Japanese wild boars are moving from mountains to villages and from villages to towns. Having made animal cruelty a social problem, this movement of wild boars presents a problem for resource management. The movement of animals has become a challenge in Japan and has compelled the Japanese to find proper methods of management. These include common issues in using resources, such as moving apiculture and capturing wild migratory fish, like tuna.

A ‘geography for creature cultures’ should define fundamental principles related to the use and management of creatures in villages and cities. Although the land area occupied by humans continues to expand, modern beliefs advocate sharing natural resources. However, humans created new disputes by privatizing lands. The ‘geography for creature cultures’ does not exist from specific land. I believe that a new discussion of the use of the earth’s natural resources will develop from accumulated geographical knowledge (Ikeya ed. 2013) and an understanding of our interaction with domestic animals will enable us to estimate the future of our culture and civilization.

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Plural Knowledges and Modernity: Social Difference and Geographical Explanations

Sarah A. Radcliffe

Abstract My paper critically examines the ways in which different forms of geographical knowledge production are positioned in relation to place, environment and Indigenous peoples. Drawing on research in the postcolonial context of Latin America, I explore how the social differentiated power relations and the politics of knowledge production play out in how geographers describe and analyse places, landscapes and livelihoods.

Keywords Decolonisation • Environments • Ethical professionalism • Gender • Geographical discipline • Indigenous knowledge • Socionatures

> [Geography is] a call to map persistently without totalization or finalization the fundamentally heterogeneous graphing of the geo (always knowing that will fail, always subjecting the failure to the collective critique of others) … readable in this sense not just for what it includes, but also for what it overwrites and covers up in the moment of representing spatially the always already unfinished historical-geographical process and power relations of its spatial production (Sparke 2005: xvi)

1 Introduction

How can we think through the geographical in relation to postcolonialism? Departing from this question, my concern today is to trace out three registers in the politics of (geographical) knowledge production which takes as its object themes of

S.A. Radcliffe (✉)
Department of Geography, University of Cambridge,
Downing Place, Cambridge CB2 3EN, UK
e-mail: sar23@cam.ac.uk

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environment, place-globality, and ethnocultural difference.[1] In the paper I lay out three ways in which Other knowledges about "environments/territories"—two concepts at the heart of geographical disciplinary endeavour—are incorporated into the geographical canon, and the work they do there. I draw upon postcolonial analysis, political geography, and critical development geography, in order to refine an approach to material inequalities, epistemic and direct violence, and forms of dispossession. Informed by my longstanding work in the Andes, my paper explores the ways in which geographical knowledge is authorised through—and in relation to—forms of Other knowledge. As such, this paper represents a much wider conversation in/outside the discipline (see among others Pickles 2004; McFarlane 2006; Escobar 2007; Hooper and Kramsch 2007; Anderson 2008; Boyle and Kobayashi 2011; Lester 2012). In other words, the objective is to contribute to postcolonial work in geography that links space, power, and knowledge. While directly arising out of the collaborative research undertaken alongside rural, impoverished and racially marked populations in the Andes and my learning there, this paper owes a debt of gratitude to many Indigenous, Hispanic and Anglo-phone geographers and anthropologists, too numerous to mention by name.

The starting point for this discussion is an indigenous racialized female subaltern, a Kichwa Puruhá woman, who when this photo (Fig. 1) was taken had just been chosen to be the "knowledgeable woman"—Kunak Warmi in the Kichwa language spoken across the Andes by over nine million people. Here she stands, named and called into being by her title (a neologism) and performatively displayed with the band of office across her body, in a public square in a small municipality in the Andean highlands of Ecuador. What does it mean to be a knowledgeable woman? In what grammars, conceptual frameworks and means of dissemination does she articulate her knowledge? And how does this knowledge intersect with, contribute to or inform the geographical discipline?[2] "Indigenous populations" carry much affective and political freight today being represented as an a priori historical presence or as constituted performatively in the present—as postcolonial critic Homi Bhabha notes, this tension "turns the reference to a 'people'—from whatever political or cultural position it is made—into a problem of knowledge" (Bhabha 1994: 146), specifically and increasingly a problem of *geographical* knowledge. Indigenous peoples are popping up all over the (Anglophone, Hispanic) geographical literature. So how are references to Indigenous people related to (geographical) knowledge, and what 'work' is this knowledge doing in the discipline today?

Given the originary importance of gendered, racialized, nationalised and located subjects to my discussion, it is imperative to explain my positionality in these debates. As a citizen and public university employee of the UK with its soft power

[1] In the paper, the term racial-cultural difference signals the exclusionary categorisation between humans that rests upon a valorisation of socially-produced embodiments. Although 'culture' has come to stand for 'race' in certain settings, innate genetic difference remains a criteria of differentiation.

[2] The Kunak Warmi starting point is arbitrary—one could start from an analysis of the film 'Avatar' (cf. Bebbington and Bebbington 2011; Briones 2011), but my collaborative work with Ecuadorian Indigenous women provides my example here.

Fig. 1 Kunak Warmi ('Knowledgeable Woman') elected in village meeting, Quimiag, province of Chimborazo, Ecuador in March 2010

agenda regarding colonialisation and multiculturalism (Hooper and Kramsch 2007), I find myself talking, acting and thinking alongside Kichwa women and diversely situated postcolonial subjects in Ecuador. Women such as the Kunak Warmi, the woman who organised this event on International Women's Day, and the diverse Indigenous women living, working and mobilising politically in Ecuador inform my understandings of the political agendas and forms of exclusion co-produced in the Andean region.

The structure of paper is as follows—I engage with three ways of linking geographies, knowledge and difference, associated with one group of authors, and two single authors (one a geographer, the second an anthropologist). I should start by saying that my critique departs from a sympathetic position analytically and normatively. The next section discusses a new sub-disciplinary field of 'Indigenous geographies', while sect. 3 examines the approach to indigenous transnational networks and disciplinary learning. Section 4 explores ethnographic approaches to Indigenous projects of decolonization, and the politics of (geographical) knowledge production, before the Conclusions.

2 Indigenous Geographies

One lens through which one might interpret the Kunak Warmi in Ecuador would be the emerging field of Indigenous Geographies.[3] The Indigenous geographies field is small and heterogeneous but key themes have become apparent, including an activist imperative to decolonise geography's interaction with Indigenous peoples' knowledges, and by this means to decolonise geographical research, publication and teaching (Johnson et al. 2007: 118). Pertinent to today's panel on 'The Environment,' the Indigenous geographies field stresses its close attention to biodiversity conservation, ecological humanities, and the interplay of environmental and social justice (Frantz and Howitt 2012: 728).[4] Indigenous geographies' most formal expression is via the International Geographical Union commission on Indigenous Peoples' Knowledges and Rights (IPKRC) founded in mid-2006 (Frantz and Howitt 2012; Larsen and Johnson 2012). The IPKRC has a threefold agenda: to encourage Indigenous geographers, to develop geographical research in collaboration with and in support of Indigenous peoples' knowledge and rights, and to bring international disciplinary attention to Indigenous geographies (Frantz and Howitt 2012: 728).

Through the lens of Indigenous geographies, the Kunak Warmi symbolizes a privileged subject whose local knowledges permit her to transform nature for the benefit of humanity. Indeed interventions premised on such understandings already exist in Ecuador. In the province of Chimborazo where the Kunak Warmi lives, a small-scale enterprise was recently established to elaborate and sell medicines and cosmetics elaborated from locally-available plant biodiversity. Involving some 600 families, the Jambi Huasi project involves Indigenous communities in biodiversity and environmental conservation and cultural valorization activities, as well as an Andean Medical School. Eighty percent of Jambi Huasi's members are (low income, rural) women who take turns collecting the plants, working in the "artisanal laboratory," and collaborating with local universities to certify organic production (guaranteeing exports to western consumers). Women's numerical dominance of the project is explained in terms of gendered place- and knowledge-making (domestic garden's biodiversity, and gender- and racially-segregated labour markets (cf. Leach 2007; Resurrección and Elmhirst 2008)). Stress is placed on the "self-generated" nature of largely illiterate women's knowledge.

Rather than speak directly from her knowledge, the Kunak Warmi is prefigured in the Indigenous geographies framework as a feminized subaltern whose knowledge would diffuse out to those attuned to listen. Indigenous geographies frame the production of knowledge primarily in terms of the Western researcher and his/her

[3] The capital letter in Indigenous is widely used, denoting a status equivalent to Western, Italian etc.

[4] The Indigenous geographies' initiative appears to be most strongly associated with white settler societies—Canada, the United States, New Zealand and Australia—where first nations/aboriginals experienced forms of post-Enlightenment violence and colonisation. By contrast Latin America—also Algeria and Kenya—is considered to comprise deep settler colonies where "the coloniality of power endured with particular brutality" (Mignolo 2000: 99).

relationship with Other knowledges (e.g. Murton 2012: 16–17).[5] In this reading, an unproblematised and apparently self-evidently Indigenous subject exists, with an autochthonous form of knowledge production, integrated into yet separate from University-based western knowledges. The researcher's unmarked positionality here is as metropolitan, who finds in the encounter with the Indigenous subject (object?) a means of loosening their inner controls. In the field of Indigenous geographies, the western researcher is imagined as retaining the power to encounter "an entire genealogical cosmology in which knowledge is created, stewarded and accessed via place-based relationships," undergo a process of ecstatic confusion and then emerge with new understandings of place (Larsen and Johnson 2012: 6). Throughout, the western researcher remains the standard and recipient of a global knowledge, enriched through a celebration of difference (op.cit: 11). Larsen and Johnson speak of how western researchers can learn through being 'out of our minds', allowing them to 'relax our inner controls' and experience the ecstatic dimension to fieldwork (2012: 4–5). "Time and again," Larsen and Johnson continue, "those engaged in Indigenous research discover the ecstatic place where the divisions and dichotomies of colonial discourse dissipate and genuine (e.g. unpremeditated, empathetic, transformative) communication begins between people occupying vastly different sociocultural worlds", which lead to transformations characterised by "pain, angst, failure, disappointment and readjustment" (op.cit: 5). Similarly, Murton dismisses western dichotomies in favour of a "sensuous world (the creaturely world directly encountered by our animal senses)," accessed through a non-literate orality (Murton 2012: 16, 17). By these means practitioners of Indigenous geographies "discover hybridized understandings of place that enhance the meaning and purpose of human life in the world" (Larsen and Johnson 2012: 5; cf. Fanon 1986 [1965] especially Chapters 2, 3; Bhabha 1986). According to postcolonial critic Gayatri Spivak's analysis of colonial power, such a description of the research encounter draws our attention to how colonial hierarchies of power are reproduced, leaving little scope for decolonization.

While a "respectful, reciprocal research relationship" (Johnson et al. 2007: 119) is to be welcomed, I would argue that Indigenous geographies perpetuates colonial divisions between Native informants and (western) researchers, and has moved only partially towards the ontological and epistemological rethinking required to decolonise geography. Part of the issue is that Indigenous geographies provide few details on how the decolonization of geography might occur, gesturing primarily to collaborative work between a western researcher and an indigenous informant, and leaving the decolonisation to occur in a way that is naturalised and unremarked. By contrast, postcolonial writers provide insights on the relations of power and difference that come into play just at the moment when relations appear to be most 'natural' or 'culturally-unmediated.' Dissecting the colonial play of desire and power, Spivak reminds us how in its very enactment imperial power ends up "obliging the native to cathect the space of the Other on his home ground… worlding their

[5] However the relative scarcity of Indigenous geographers in the discipline is also noted.

own world" (Spivak 1985a: 253).[6] Spivak's analysis suggests that Indigenous geographies' move to disrupt the discipline occurs without the subaltern contributing to new epistemologies. In other words while it is not necessarily problematic to rethink knowledge production in/through affect, embodiment and fascination (Anderson 2008), questions are raised about the consequences of this particular affective tone, and the knowledges produced. Specifically we must focus in on how the sub-discipline of Indigenous geographies engages with racial-cultural difference. In this, postcolonial critic Homi Bhabha usefully distinguishes between the liberal celebration of cultural diversity as a common "good," a celebration that offers no challenge to dominant culture and coexists with racism, from a concept of cultural *difference* that signals incommensurable alterity and Otherness, a more profound challenge to dominant society (Bhabha 1990; also Mignolo 2000). In my view, 'Indigenous geographies' remains strongly associated with a liberal framework of cultural diversity, and hence cannot acknowledge the epistemic violence through which (western) disciplinary knowledge comes to have the theoretical and institutional foundations through which the encounter with the Indigenous Other is initiated and to which it returns.

In part this arises as Indigenous geographies claims for itself the role of translator of Native information, which as Gayatri Spivak notes means "considering the 'native' as object for enthusiastic information retrieval and thus denying its own 'worlding'" (Spivak 1985b: 245). Indigenous geographies emphasise the enlightened and privileged position of the (western) researcher as a neutral yet culturally sensitive mediator-subject through whom Indigenous knowledges can be brought into and reflected upon in the (western) academy. 'Rescue geography' is the order of the day, providing diverse examples through which to enrich university curricula (e.g. Johnson 2012; cf. Kapoor 2008: 47). As key interlocutors between the cultural Other and conservation policymakers, Indigenous geographies position themselves as culturally-sensitive experts, speaking on behalf of racialized populations to show how "new goals [of co-management] are both bio- and ethnocentric" (Coombes et al. 2012: 815). Geographer Katharine McKinnon points out how NGO and state professionals' advocacy of Indigenous knowledge over western scientific knowledge can be become "a narrative through which 'problematic' policies of the past could be explained and an allegiance with the 'local community' declared" by the professionals, while all the time retaining a privileged and unthinkingly colonialist positioning intact (McKinnon 2006: 30).

In this respect 'Indigenous' knowledge owes its valence and substance as much to professional distinctions between Self and Other as to grounded content. Shoring up these postcolonial distinctions reorients Indigenous geographies away from politicised struggles over resources and territory, and re-sutures the Indigenous subject to the "community," a concept presuming the timelessness and cultural

[6] Spivak draws the notion of cathexis/cathect from Freud, who used it to diagnose the investment or injection of libidinal energy (Spivak 1985a). By 'worlding' Spivak refers to the process whereby dominant discourses come to distinguish one part of the world from others e.g. 'Third World.'

difference of Indigenous peoples (e.g. Coombes et al. 2012). Via this move, Indigenous geographies arguably throw out the baby of contested meanings around socio-natures with the bathwater of "false consciousness" (Coombes et al. 2012 op.cit: 812–813). Geographers stake a claim to authority over such translation processes because of a disciplinary capacity to map (pinpoint) and access (through an affective/activist stance) local knowledge systems (cf. Briggs 2005).[7]

Across policy and intellectual endeavours, Indigenous knowledge becomes the privileged marker of an emerging sub-disciplinary agenda, which I would identify as the impetus to seek a route out of modern discontent, specifically anxiety about environmental risks and climate change trends. The Jambi Huasi project illustrates one policy response to such anxiety that seeks to conserve biodiversity through conservation measures while drawing upon "locally-specific and culturally appropriate" knowledges thereby contributing to the preservation of cultural and environmental diversity.[8] According to a project document,

> The objective is to preserve the environment and nature, eradicating deforestation and the burning of the heaths. Agro-ecology views the soil as a 'living organism' and as such, the different organs complement each other and are mutually influential. This is the reason why the producers of medicinal plants practice the association and rotation of crops, the use of vegetable fertilizer among other measures with the aim of keeping the soil alive.

As an emergent critical literature documents, the distinctions between cultural diversity and biological (plant) diversity are frequently blurred in such policy formulations, echoing both nineteenth century colonial and twenty-first century policy imaginings of Indigenous peoples in distinctive environments (Anderson 2008). Bios-cultural preservation policies can in this sense be read as anxiety-prompted, ad hoc attempts to re-assert the fragile figure of the human not as a "nature-transcending being" (Anderson 2008: 165) but rather as a nature—preserving being, a role to be undertaken by those (according to western imaginaries) closest to nature, namely Indigenous groups. The Indigenous geographies group arguably speaks directly to this impetus for translating forms of blurred bio- /culturally-diverse socio-natures into policy-amenable formats.

As Indigenous knowledge becomes more widely used in problem-solving (whether in development or public policy) questions about who holds knowledge, what authority it grants them and in what spheres, become highly politicized. "Rather than resisting western science, indigenous knowledge appears to be becoming ever more complicit as it becomes appropriated by 'development', a process that will only harden as indigenous knowledge becomes increasingly institutionalized"

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[7] "Whilst indigenous knowledge may indeed be represented as a valid and relevant alternative to western science, realistically it needs to be seen as something more nuanced, pragmatic and flexible, perhaps even provisional, highly negotiable and dynamic" (Briggs 2005: 111).

[8] Jambi Huasi documents note the "Andean Medical School is a space in which the community midwives and the Yachaqs [literally 'knowledgeable ones' in Kichwa, translated as Shamans/healers] support communities with their knowledges. Additionally, research is undertaken about agricultural production and the conservation of the environment."

(Briggs 2005: 111). Development entrains the appropriation of Indigenous knowledge in ways that are defined globally as local, unsystematic and practical, leaving Northern researchers and development experts secure in a colonialist politics of knowledge (Briggs and Sharp 2004). In this sense, the Jambi Huasi project echoes and materialises a form of global development that reworks poor peoples' discrete knowledge in the name of biodiversity conservation—Andean women's knowledges about herbs are the basis of a sufficiently-safe but not commercially up-scalable remedy. In this respect, the Jambi Huasi project keeps firmly in place the separation of western science (laboratory science, medical trials, western medicine) from subaltern knowledges (unregulated, self-administered, hand-picked products). My core point here is that local processes of knowledge production cannot be analysed solely on their own terms, but must be analytically and theoretically embedded within global dynamics of knowledge production viewed through a postcolonial lens. Conceptually and materially, Jambi Huasi fails to address the ways that market economies marginalize Indigenous groups, the material impoverishment that results, as well as the ongoing marginalization of Indigenous conceptual knowledges.

So why are Indigenous geographies emerging now (Shaw et al. 2006; Panelli 2008)? Why should geography as a discipline be investing in "subjects and objects of knowledge in geopolitical terms, inscribing them with social, racial and gendered characteristics" (Schiwy and Ennis 2002: 3)? A preliminary response to these questions points to geography's situation in a widely-held public distrust of unchecked industrialisation and ecological disruption. Accordingly, the logic of environmentalist countermovements is bound up with green modernisation and a widely institutionalised politics of nature, to which geography as a discipline contributes its expertise, practical knowledge and upon which it depends (at least in part and unevenly) for its claim to 'relevance' and 'impact' in the neoliberalising university. In this respect, a review of the field recently reported that "a wide range of these Indigenous geographies now enjoys considerable international recognition, including critiques of environmental management politics and legal struggles surrounding water resources, traditional foods, cultural heritage and wildlife" (Panelli 2008: 806). The environmentalist agenda associated with 'Indigenous geographies' can also be understood as a specific (sub-disciplinary) form of what Argentine anthropologist Claudia Briones terms "metropolitan alternativism" arising from "the self-critique of its own conditions" (Briones 2011: 317). In relation to the geographical discipline, Indigenous geographies furnish a strand of environmentalist geography with the possibility of presenting 'new yet old knowledges,' heightened by a patina of cultural distinctiveness and atavistic authenticity. Such academic re-fashionings remain deeply embedded within a project of improvability (improvability of the geographical discipline, improvability of human responses to environmental destruction). Responding to this anxiety-knowledge production-disciplinary positioning, projects such as Jambi Huasi galvanize broad support precisely because of their powerful conjunction of elements—Indigeneity, environmental objectives,

'third world women,'[9] and an-Other form of knowledge production. Yet they ultimately speak more to a search to western dilemmas than to a decolonial move.[10]

Claiming to speak in the name of 'the indigenous Other'—framed intrinsically as cultural diversity—the field of Indigenous geographies diverts a particular grammar of local knowledge associated with Otherness via a sub-disciplinary channel associated more with western researchers than with the forms of power through which the very category of Indigenous comes to be sutured to the category of 'Environment' and/or 'Knowledge' (cf. Blaser 2010). As discussed below, Indigenous geographies are but one part of wider constructions of place, environment and power through which the nature of Indigeneity—the double meaning of nature is deliberate here—is being cartographed in national parks, carbon sequestration schemes, and REDD projects in ways that speak more to global political economy than to local forms of knowledge. In other words, the Indigenous geographies initiative reinforces a researcher-object dynamic that departs from and reiterates the position of Indigenous peoples as the West's "self-consolidating Other" (Spivak 1985a). While the Indigenous geographies field—rightly—attempts to articulate a robust critique of uneven geographies of power, culture and knowledge production, it remains constrained by an unproblematised understanding of the postcolonial politics of knowledge. While gesturing towards the need to decolonize the discipline of geography, the field of Indigenous geographies offers us few pointers as to how that decolonisation might occur.

3 Rethinking Place Through Indigenous Movements

If the Indigenous geographies field approaches questions of knowledge, geography and environment via the category of Indigenous knowledge, a second form of analysis re-thinks geographical theorisation of place by examining the empirical dimensions of Indigenous transnational organising. For my purposes today, the work of geographer Noel Castree can act as a metonym for this analytics, specifically his widely cited *Political Geography* article 'Differential geographies: place, indigenous rights and 'local' resources' (Castree 2004).[11] In the article, Castree examines three key (Anglophone) geographical theorists of place—Michael Watts, Doreen Massey and David Harvey—providing a summary of their key arguments, before

[9] Pace Mohanty (1998), I deliberately use this outdated label precisely to signal how project funding is embedded within colonial discourses of North/South difference which pinpoint female subjects as the most 'Other' and less powerful in global power dynamics.

[10] The Jambi Huasi initiative has international funding and institutional support from—among others—the German development agency, the Dutch Embassy, the Ecuadorian export promotions team, the United Nations Development Program, and Japan.

[11] I am highly conscious of the fact that in a regular length article it is impossible to address all facets of the question, so these comments are complementary and supplementary to the piece.

turning to an account of transnational Indigenous social movements as a means to rethink the assumptions and expectations around place, politics and resource control embedded in contemporary (Anglophone) geography. Drawing on rich regional examples and multidisciplinary literatures, Castree juxtaposes the conceptions of place and territory that he identifies as informing Indigenous political mobilisation, against the conceptions of space offered by the theorists. In this respect, Castree offers a different perspective to 'Indigenous geographies' as he approaches Indigenous social movements having first thoroughly critiqued key (western) geographical thinking on place. Animated by a theoretical imperative such work constructs the Indigenous subject "as a programmed, nearly-selved Other of the European and not as its binary opposite" (Parry 2004: 20, summarising Spivak; also Sparke 1998: 310). My question remains: how can this analytical framework serve to decolonise geography while generating a vocabulary through which to approach the connections between place, environment and difference?

Pursuing Castree's focus on indigenous networks and international rights frameworks positions the Kunak Warmi as a political and globally-networked subject and active member of a national rights movement embedded in a world-spanning network of like-minded social movements. In effect this lens analytically frames our Kunak Warmi as part of CONAIE Ecuador's main indigenous confederation, which has been a major player in pressing national and international institutions to recognise and implement rights (Yashar 2005; Andolina et al. 2009). Since the 1980s CONAIE has galvanized international support for autonomous territories and forms of resource and environmental control embedded within recognised administrative spaces. Recent Ecuadorian maps represent Indigenous presence across the national territory in territories: for example, in programmes to mitigate climate change cartographies represent Indigenous populations as discrete and contained, already awarded extensive territories and securely remote from urban centres and unentangled with non-Indigenous groups (e.g. Map 8 UNEP 2010; cf. Radcliffe 2011). One mechanism by which these territories have been established is the Socio Bosque Program (Spanish for 'Forest Partners'), which brings together Indigenous populations with globally networked political agendas in ways that seek to protect and facilitate bios diversity. Hoping to deliver a solution to poverty, forest destruction and global climate change, Ecuador's Socio Bosque program calls upon Indigenous subalterns such as the Kunak Warmi as political subjects in a global polity to implement climate change mitigation measures known as REDD, Reducing Emissions through Deforestation and Forest Degradation.[12] Let us examine how this program frames and engages with racial-cultural diversity, environment and knowledge.

[12] Established in 2008, the Socio Bosque Program garnered technical assistance from Conservation International, and represents one facet of Ecuador's efforts to present itself in the vanguard of emissions-reducing measures, most famously in the Yasuní-ITT Plan in which petrol would remain unexploited in return for international payments. The Socio Bosque Program aims to protect over four million hectares of forest, reduce emissions, and improve wellbeing of around one million people in the poorest areas. At the latest count, 12.8 % of target forests had been protected, and 5.6 % of potential beneficiaries incorporated into the Program. There is a large, mostly technical and partially geographical, literature emerging on Socio Bosque that is beyond my scope here.

Socio Bosque represents one articulation of resource control, place and globally-connected agendas that speaks directly to geography's disciplinary concern with knowledge, environment and difference. While not an explicit priority in Socio Bosque, Indigenous peoples find that their spatial distribution and material embeddedness in biodiverse areas such as the Amazon result in their incorporation into the program's governmentality. Creating an equivalence between biodiversity and cultural diversity, Socio Bosque cartographs Indigenous peoples as present—and policy-relevant—in remote, rural and environmentally rich areas. In one way, this designation of "Indigenous territories" speaks to cultural (difference) recognition, the sign under which Castree's paper analyses them. However as legal scholar Karen Engle shows, the conditions and consequences of such territorial awards are frequently based on elite-defined *cultural* criteria rather than Indigenous criteria of *autonomy* and self-determination (Engle 2010). Although seeming to bolster Indigenous place, such political settlements in effect reify an ontological separation of Indigenous and non-Indigenous geographies, while obscuring on-going processes that result in Indigenous dispossession and displacement (the ongoing encroachment of diverse actors such as petrol companies, settlers some of them Indigenous groups from other locations, and drug traffickers). Consequently, connections between territory, knowledge and cultural-racial difference must be read in relation to the political processes through which postcolonial states have—and continue to—structured cultural-racial difference in relation to territory, Otherness and power.

Castree's discussion rightly raises important disciplinary questions about our conceptualisation of place and does so in ways that usefully unite a conception of place with a global horizon of political mobilisation, "the conjoint local *and* translocal nature of these struggles" (Castree 2004: 137, original emphasis). Yet the framework arguably excises important dimensions of the political geographical and epistemological challenges raised by Indigenous movements; I raise four points here. First, the *Political Geography* article gathers substantive data from around the world on Indigenous movements as empirical evidence which is then crafted by the Northern researcher into a theoretical argument. The analytical move of this kind has been identified and critiqued by postcolonial writers for reifying and perpetuating the colonialist boundaries between Self/Other, mind/ body, knowledge/practice (Spivak 1988; Briggs and Sharp 2004). In the framing offered by Castree's piece, a homogenised Indigenous subject is not granted the heterogeneous viewpoints, conceptualisations, and epistemological frameworks that different western theorists are. As discussed in the next section, regional research quickly reveals numerous—at times conflicting and always hyper-diverse—epistemologies that Indigenous movements bring to the table (Sanjinés 2002: 40ff). Hence the move to present Indigenous geographies as 'rupturing' western explanations and epistemologies of place is not innocent, as "indigenous systems of knowledge are reified by the very modern structures that marginalize them" (Briones 2011: 318; also Kapoor 2008). In one way, the *Political Geography* piece manages to provincialize Europe (and its geography) by inserting transnational Indigenous movements analytically and metaphorically. Yet according to decolonial intellectuals in Latin America, such a move must also be interrogated for its (limited) impact on the unequal terrain of

knowledge *production* (cf. Legg 2007). As scholars employed in a metropolitan university, western researchers including myself have access to the library resources, time for thinking, and material security to permit the imaginative—if not always the embodied—engagement with the "transnational Indigenous movements" of the world. In his think piece, Castree detours imaginatively via the indigenous movement from a position that is fundamentally postcolonial yet which is not acknowledged as such (Spivak 1985a, 1988). Feminist geographical critiques of the masculinising 'view from nowhere' alert us to the power-inflected ways in which knowledge is being constructed here (Massey 1991). Provincializing Europe must arguably be combined with a systematic recognition of the intervention of the non-European subaltern in the unfolding of modernity (Mignolo 2000; Sanjinés 2002).

Second, the framework articulated in *Political Geography* privileges (Indigenous) resistance as if that were an unmediated expression of identity, place and politics coming from a primarily politicized subaltern. "There is a tendency to associate local knowledges of the marginalised with a 'resistance' to Western hegemony, or indeed a 'resistance' to local relationships of power" (Smith 2011: 603). In this way, the local comes to equal resistance equals subaltern knowledge equals new theoretical insights, belying the politics of knowledge production at each step in a chain of (contested, heterogeneous and variously participatory) research processes. In effect the "hyperbolic construction of the subaltern" (Kapoor 2008: 53) rhetorically contributes to and makes possible the forceful criticisms of non-Indigenous theorists.[13] Moreover, such an interpretative practice ignores what Spivak and postcolonial writers have highlighted, namely that subaltern self-representation may strategically essentialize complex heterogeneities of identity, interests and difference precisely in order to make a sustained and powerful argument 'from below.' As extensive work on social movements in the South demonstrates, resistance discourses and representation tend to focus on key actors (United Nations infrastructures, International Financial Institutions, transnational corporations etc) in ways that obscure the complexity of movement constituencies as well as the role of intermediaries (non-governmental organisations, northern activists, academics) (e.g. Li 2010; Blaser 2010). The *Political Geography* piece, by eliding the processes of constructing cultural difference as a sign under which to mobilise, thereby obscures a crucial dynamic between power, cultural-racial difference and territory (Spivak 1985a: 131; Parry 2004).

Third, diverse institutional actors including nation-states, transnational development networks, and international financial institutions work to shape and reproduce the very grounds upon which "cultural difference" can be expressed, mobilised, and grounded in geographical imaginations (see, among others, Li 2000; McKinnon 2006; Andolina et al. 2005). To clarify, I am *not* arguing that indigenous identities are somehow inauthentic and only produced to demand by 'external' agents. The point is to acknowledge—and to unpack in research and analysis—the ways in which subjectivities, political modes of action and the postcolonial game of Self-Other

[13] For reasons of space, I leave aside here questions about the process of gathering and comparing information on transnational Indigenous movements.

differentiations are constituted at scales beyond the local and the transnational. So as coloniality[14] was folded into (post-independence) nation-states so they produced cultural difference and moulded Indigenous subjects and geographies, first by dismantling Indigenous forms of sovereignty, then by entraining the subaltern as muted others in their own lands as much as through the knotting together of state formation, capitalism and development (Wainwright 2008). In other words, the scale of the postcolonial nation-state co-constitutes the forms of disciplining and governmentality of spatial-cultural-epistemological difference of 'Indigenous' categorisations. For this reason, Indigenous movements struggle over citizenship and forms of social, economic and political rights articulated at the scale of the nation-state and not merely for defensive local places (and often not secession from existing nation-states). For example working in concert with various Indigenous and non-Indigenous movements, CONAIE inserted into Ecuador's 2008 Constitution an extensive rights-based agenda that included a firm commitment to a form of socio-cultural-bios governmentality known as Sumak Kawsay (Living Well, in Kichwa), an agenda grounded in indigenous knowledges of living socio-natures, environments and life-forces (Radcliffe 2012). Unlike Castree's account, Sumak Kawsay speaks not to locally-defended 'Indigenous' places arising from transnational action but to a nation-state territory in which Indigenous knowledges legally inform statecraft for indigenous *and* non-indigenous citizens. This is precisely where postcolonial questions about environment, cultural-racial difference, and knowledge erupt in relation to Indigenous demands for resource control.

Fourth, postcolonial accounts of environment, knowledge and difference necessarily speak to the epistemic and material violence in relation to which indigenous movements emerged across the world. Until the mid-twentieth century, nation-states under whose purview Indigenous populations and territories exist had forms of governmentality and direct sovereignty that structured and justified deeply violent, geopolitically-embedded and contested projects. By excluding the nation-state from its purview Castree's paper leaves in place a common misapprehension of the status of Indigenous movements, namely that they are in some (often unspecified way) sovereign actors with equal status to other political power-holding entities. In other words the article recognises a fundamental antagonism but leaves in place the notion that this "colonial relationship [is] a symmetrical antagonism" (Parry 2004: 14), going no further to unpack the striated geographies of postcolonial power. In this regard the infrastructures of human rights that Castree discusses were awarded to Indigenous populations *qua* Indigenous nearly 60 years *after* 'universal' human rights were codified: the 1948 UN Charter on Human Rights, followed in 2007 by the UN Declaration on the Rights of Indigenous Peoples. Between these dates, decades of dispossession unfurled through place-specific combinations of racialized denial of subjectivity, skewed legal systems, and discourses of progress/ development/ modernity in ways that suspended the applicability of Human rights

[14] By coloniality, postcolonial critic Walter Mignolo building on Anibal Quijano's work refers to the ways in which colonial power relations and forms of difference co-emerged with modernity, being the dark side of modernity and intrinsically shaping it (Mignolo 2000).

to Indigenous groups. Moments of particularly acute and rapid forms of dispossession were associated with neoliberalism and post 9/11 securitization (on Latin America, see Yashar 2005; Postero 2007; Radcliffe 2007). Exemplifying this is the Socio Bosque Program which—while seemingly speaking to Indigenous demands for local control over territories in robust global norms of cultural and environmental protection—in fact generates an Indigenous critique that cannot be encompassed within the terms of a local-agenda-in-global-networks framework. Indigenous movements primarily the Ecuadorian Amazon confederation CONFENAIE (a CONAIE affiliate) rail passionately against Socio Bosque's effect of *undermining* their economic, political and social rights. They scorn the Program's 'local use' of their 'local' knowledge while remaining deaf to Indigenous demands for informed (i.e. knowledgeable) prior consent on all major infrastructure and extractive projects that continue unabated in/around/overlapping with Indigenous 'territories' (CONFENAIE 2009). Linking REDD with international markets and neoliberal mechanisms—each of which over recent decades heightened impoverishment and entrenched political marginalization—Indigenous movements reject Socio Bosque precisely as "a continuation of the type of policies that have impeded their quest for sovereignty and self-determination" (Reed 2011: 525). Although appearing under the sign of Sumak Kawsay Indigenous knowledge production,[15] Socio Bosque operates to centre exclusionary spaces and types of knowledge while disavowing subalterns.

At the heart of these power-laden constructions of rights, territory and difference lie questions of gender. From the perspective of the Kunak Warmi and other Indigenous women, the Program entails serious curtailments of her knowledge, agency, environment and territory. Despite women's status as citizens and members of indigenous movements, Socio Bosque does not extend women's (collective or individual) rights. Socio Bosque's requirements for registration and benefits include tenancy or possession of forests and a national ID card. Due to overlapping exclusions of location, racialization, gender and class, Indigenous women are least able to command these resources and codifications of rights and so are least likely to command the resources brought by the program (Radcliffe 2013). According to a Sápara Amazon woman, the Socio Bosque fails to protect indigenous territory from expropriation by third parties while strengthening state control over subsoil resources,

> I met with [staff from] Socio Bosque and asked them, 'what is happening? They are buying up our territory.' They asked me how I knew. And then payments—no one gives away money for conservation, conservation of Sápara territory. And he [sic] said, 'No, here above is your indigenous land, and below is the state's.' That's what he told me! (Gloria, research interview in August 2012)

Moreover, payments for REDD services are made via communities and invested in Ministry-approved local plans from which female knowledges, larger-scale and/or politicized activities are frequently excluded.

In other words the intrinsically geographical story behind transnational processes of Indigenous place-making prompts urgent questions about the politics of

[15] That is, the Socio Bosque program has to comply with a constitutional commitment to Sumak Kawsay.

knowledge production and power. The very processes of dispossession and resistance that generated Indigenous local–global networks in the first place are currently re-working the global, national and 'place-specific' geographies of environment, as addressed here in relation to climate change mitigation measures. Such local-national-transnational-making processes take for granted indigenous emplacement and global connectivity, yet they often leave in place the very processes that caused dispossession initially. The main point I want to draw out here is that geographers need to acknowledge first, the ways in which Indigenous knowledges are breaking out of 'local' places (through a contentious politics of citizenship), and to unpack the postcolonial and power-drenched relations through which Indigeneity, Environment and Knowledges are becoming cartographed onto specific places, and in relation to specific subjects and forms of knowledge production. It is within these spaces that the particularities of knowledge and the particularities of place must arguably be found; there is no 'universal' knowledge about Indigenous subalterns, place and cultural-racial difference but a multiscalar account with room to include non-national spaces/places, nation-states, transnational networks, and institutions of global governance (Schiwy and Ennis 2002; Escobar 2008; Andolina et al. 2009).

Metonymically, the *Political Geography* piece ultimately offers a "benevolent but Eurocentric appropriation" and analysis of the relations between place, difference and environment (Sparke 1998: 311). While the piece identifies Indigenous *practices* as rupturing disciplinary paradigms, there is no acknowledgement of epistemic violence, Indigenous epistemologies, and processes of Difference production that precede and inform transnational networking. As in certain interpretations of Indigenous knowledge, this appropriation highlights the practical and technical 'skills' of Indigenous peoples rather than their forms of Knowledge that is found in/through a subject of difference. Moreover, the working assumption is that the direct unmediated accumulation of experiences of an Other viewed holistically 'from above' present a panorama of effects for the western researcher to interpret, contrasting it with theoretical constructs originating in the western academy. Rather than approaching cultural-racial difference through the humanistic sensuality of 'Indigenous geographies,' this politics of knowledge is a disembodied, unmarked view from nowhere, arising from and contributing to a disciplinary authority to produce knowledge, un-entangled with the violent dispossessions and forms of governmentality that generate mobilisation.

4 Globalization and Decolonization: Politics of Knowledge Production and Ruptures

If 'place' is Castree's entry point into rethinking geography through the Other, globalisation is the anthropologist Mario Blaser's (Blaser 2010). Drawing upon Latour, Haraway and ANT, Blaser narrates an ethnographic account of an Indigenous group's encounter with modernity and various projects to rework it. Working alongside the Yshiro in the Chaco region of Paraguay, Blaser explicitly engages with the

questions raised in my previous sections about how geographers might write/know about environment-place-difference. He neither casts himself as translating Yshiro knowledge into western knowledge nor as re-scripting disciplinary theorisation through the Other. Rather he sees himself as story-telling globalisation as a way of practising knowledge, constructing a narrative of the Chaco's entanglement with modernity in a way that reflects Yshiro cosmologies and ontologies, while assuming complete personal responsibility for the specific narrative developed.[16] Specifically Blaser draws on geographer Doreen Massey's arguments about a global sense of place to distinguish between an authorised imagination of globalisation and what he terms a 'rupturist' story—exemplified by Massey's global sense of place—that breaks with modernity as a "rule, system of knowledge and representations" (Blaser 2010: 10).[17] Critically for my argument here, Blaser goes beyond Castree's analysis to argue that rupturist accounts are themselves problematic because although they prevent modernity scripting itself as pure and self-contained, the rupturist story is not the Indigenous peoples' story largely because it is not made with Indigenous trajectories, ontologies and practices (Blaser 2010: 15, 17), a deficiency his book attempts to redress. In purpose and practice, Blaser's ethnography combines a decolonial move to engage with but not speak for Indigenous subjects, informed additionally by an analysis of the ethical professionalism shaping Yshiro lives. These elements are blended with a systematic attention to the epistemic and material violence that operate within and around biopolitical projects for improvement. In this sense, his book "shift[s] the analysis of racial discourses towards the violent, 'lived' politics of Indigenous dispossession" (Lester 2012: 135).

Informed by this geopolitics of knowledge production, our Kunak Warmi becomes a key theoretically-informed actor whose entrainment in postcolonial violence and dispossession informs her efforts to produce knowledge Other-wise. Embedded within place-specific interactions between Indigenous peoples, the nation-state, ethical professionalism and development, the Kunak Warmi is recognised as a knowing and critical subject whose ontological starting-point represents profound challenge to western ways of thinking and being. There are two main consequences of this positionality that I wish to elaborate here. Firstly, Andean Indigenous groups articulate their understandings of environment, place, and cultural-racial difference not necessarily around western notions of nature versus culture, but in terms of multiple socionatures containing animate, political, and profoundly significant actors that western epistemology would place in the category of 'nature.' To offer one example, in her critique of the Socio Bosque program, Gloria continued to say:

> [The Socio Bosque team] said, 'No, here above is your indigenous land, and below is the state's.' That's what he told me! I said, 'What did you say? We have a spirit that lives within

[16] Drawing on Actor Network Theory, Blaser suggests different narrations of modernity and their embodiments in practices "contribute to perform different forms of globality" (Blaser 2010: 9).

[17] In their texts, Blaser (2010) and Castree (2004) coincide in interpreting Massey's diagnosis of geographical imaginations as non-innocent, and her argument that certain geographical imaginations are constitutive of dominant understandings of modernity. They differ in that Castree (and Massey herself) script power-geometries as if they personally were outside them, whereas Blaser situates himself within practices of knowledge production (cf. Fall 2014).

> the earth. The live spirits live there; for this they say *uku runa* live in the mountain. [The earth is] alive. Where are they [*uku runa*, the earth-beings] going to live? This exploitation is going to throw everything out. (Gloria, August 2012)

In this context as elsewhere in the Andes, Indigenous resistance to dispossession departs from the existence of "earth-beings" (de la Cadena 2010), political entities with autonomous relations with humans and their projects couched, rather than property and territorial encroachment. Whereas geographers have recently articulated the theoretical and philosophical grounds upon which modern categorisations of human/non-human can be re-thought as post-universalism, Andean Indigenous border thinking carries such insights forward into the political realm, grounding these theoretical insights in regional contexts and putting them to work in political struggles. In this sense, the insertion of Sumak Kawsay into the Ecuadorian Constitution represents not merely a commitment to a social rights-based agenda but also the extension of the right to well-being of a living earth-being, the Pachamama. Previous geographical accounts of Indigenous mobilisation and claims for rights tend to interpret the public sphere as one consisting of human actors, sometimes embedded within assemblages of NGO advocacy and internet technologies. If however research can recognise the existence of Other political ontologies in which non-human/more-than-human beings are political actors with specific forms of power, relations with (non)humans, and interests alongside human political actors (De la Cadena 2010), this offers a possible avenue to decolonize geography. To clarify, practices of resistance translocally arise from and nurture political ontologies that address the urgent debate on how to establish (ethnocultural) places and how places might be the building blocks to (alternative) practices and conceptions of territory, power and racial-cultural-natural difference.

Andean Indigenous intellectuals debate how to re-cast the relationship between power and territory in terms that speak to an epistemological decolonization of rights, place and difference. Decolonization provides an umbrella term for a project that seeks to rethink modernity leaving aside coloniality, by drawing on what post-colonial critic Walter Mignolo terms 'border knowledges' (Mignolo 2000), and Blaser terms 'border dialogue' (Blaser 2010). In other words, decolonization "registers modernity from within the subaltern's own belief system … [taking into account how] Indigenous and modern narratives do not exist on a one-way track but, rather, in a constant state of transculturation" (Sanjinés 2002: 57). Expressed in terms of an upturning—Pachakutik—of the code by which coloniality operates, Andean decolonization names an agenda for profound rethinking of the categories, relations and values that inform decision-making and participation in polities (Aparicio and Blaser 2008). Andean Indigenous subalterns rework the ontologies of the political from within a complex field of power and agency, in ways that re-work the relationship between territory, governmentality and citizenship as it has been canonised in western theory (cf. Spivak 1985a; Sparke 1998, 2005; Walsh et al. 2002). Through this register, our interpretation of the Kunak Warmi acquires an epistemological and ontological significance as it relates to Indigenous conceptualizations of state formation and territorial autonomy in relation to human and more-than-human political actors. Since the late 1980s CONAIE has overseen a deep

consultative discussion around what they term a plurinational state, a model profoundly challenging to the Westphalian state and citizenship (González et al. 2010; CODENPE 2010, 2011; Gros and Foyer 2010; Leyva et al. 2008; Laing 2012). This state-oriented politics reveals that multifarious Kunak Warmi are actively contributing to the theorisation and philosophical and epistemological debates concerning how to construct a decolonial polity, that leaves in place the formal boundaries of existing postcolonial states yet radically reconfigures the spatial/ human/ more-than-human territorial and decision-making dynamics within them.

The second key point to come out of an engagement with Blaser's ethnography is the imperative to engage descriptively, analytically and politically with geography's disciplinary investment in what historical sociologist Karl Polanyi terms 'counter-movements,' or ethical professionalism. Countermovements of intellectuals, policymakers and others have long intervened to protect certain vulnerable populations from the worst depredations of the market economy (Li 2010).[18] Two key points need to be made here. First, ethical professionalism entails specific postcolonial consequences for knowledge production:

> The professional is a subject who is able to 'translate' one society to another, to allow the urban West (or the colonial administrator) to understand the Others whom they are supposed to administer. They may also be the 'rescuer' of cultures and societies that are on the verge of being lost forever. This mythical entity is also a transforming agent whose knowledge may allow interventions to transform local life" – civilise it, make life better, or emancipate. Yet "each of these mythical figures is imagined to be removed from the machinations of politics who are posited as existing in the service of an immutable moral good – the good of improvement and advocacy… a moral duty that is above politics. (McKinnon 2006: 26; also Briones 2011)

The echo with the Indigenous geographies field is, to my view, striking. To provide an example: in the Andes development professionals become mired in producing knowledge about who and where Indigenous peoples are, and how they should be positioned in projects for improvement (Andolina et al. 2005).[19] In both Indigenous geographies and Indigenous development, the space for encounters between (ethical) professionals and what we might term the 'new Tribal' is often analysed as a space of "conciliation, compromise and joint understanding, and [it] opened space for seeing all parties in attendance … as equal and potentially united, voices" (McKinnon 2006: 32).

A decolonial perspective by contrast brings these ethical professional practices and knowledge productions within the remit of a critical analysis. With the rise of environmentalist movements, the protection of Indigenous populations has the additional effect of "repeat[ing] the colonial tendency to overestimate the bonds of community and underestimate or misread the mechanisms through which dispossession occurs" (Li 2010: 388). Such miscalculations do not prevent the rolling out of such

[18] Across the South, countermovements through colonial and postcolonial history attempted to separate out Indigenous/Tribal places from land sales and market mechanisms (see Li 2010 on African and Asian examples).

[19] Following a similar argument, Briones points out that metropolitan alternativism's self-critique "does not escape the dynamics by which indigenous systems of knowledge are reified by the very modern structures that marginalize them" (Briones 2011: 318).

schemes in the early twenty-first century; in development projects that iteratively protect nature and Indigenous groups (as if in a perpetual motion machine) (Anthias and Radcliffe, no date), Otherness is represented in ethical professionalism as a means of critiquing modernity from within "as a hybrid object … through a production that weaves skeins of science, politics, economics, law, religion, art, fiction and where 'culture and nature are intertwined'" (Briones 2011: 316, citing Bruno Latour). According to anthropologist Claudio Briones, Nature in the form of socio-nature embodies rationalities and can serve "as an arriving point for redemption" (Briones 2011: 315). Moreover—and key to geographers' engagement with these issues—the Tribal slot is constituted through the circulation of the notion that Indigenous populations are natural conservationists able and willing to subsume market-oriented options to a wider agenda of earth-protection (Greene 2006).[20] Post-universalist discussions in geography bring to our attention the investment of professional activities (whether development, colonialism or academic activism) in magnanimity as a function of desires to work against/within modernity (Kapoor 2008, Chapter 4 especially p.63ff.).

Taking these points forward into a decolonial geography, an analytical focus on ethical professional knowledge production together with (and in conversation with) the recognition of more-than-human political ontologies could be of interest to geographers. Drawing together the previous sections, we can now emplace the geographical analysis of territory, environment and difference in a postcolonial and post-universalist frame departing from three key conclusions. Point one: The issue becomes "less the indigenous politics of representation than the politics of [geographical] representation itself, … to identify different 'political ontologies' and analyse why some of them have a chance and urge to dominate others" (Briones 2011: 321). Point two: important trajectories and contexts exist in which to take forward geography's post-universalist approaches. Existing geographical literature on post-universalism has tended to examine the divisions between humans/between humans and nature in relation to a colonial past (Anderson 2008; Lester 2012), I suggest that the present is also a key area for this inquiry.[21] Contemporary coloniality continues to associate certain kinds of humans (and their agency) with a category of "biodiversity," hence necessitating a critique of the ways that more-than-human and Indigenous subjects are positioned in modernist ontologies.[22] The existence of more-than-western ontologies recast the relationships between territory, racial-cultural difference and more-than-nature. Point three: to explore critically the contemporary mechanics by which humanist interventions continue to parse distinctions between (different types of) humans and the nature/culture divide. As in

[20] This 'greening of the Tribal slot' during a period of neoliberal retrenchment is at times perceived as 'contradictory' (e.g. Greene 2006: 347), yet from my perspective it is not contradictory if we place the constitution of the Tribal slot and neoliberal measures within the broader frame of coloniality and its forms of knowledge production.

[21] Consider for instance the 1992 Global Biodiversity Strategy, "Cultural diversity is closely linked to biodiversity. Humanity's collective knowledge of biodiversity and its use and management rests in cultural diversity; conversely, conserving biodiversity often helps strengthen cultural integrity and values."

[22] Here the project might explore how Frantz Fanon imagined the path "toward a new humanism ...." (Fanon 1986 [1965]:9; Bhabha 1986: xx; cf. Boyle and Kobayashi 2011).

polices that distinguish between a marked Indigenous subject/nature and an (unmarked) western consuming/ environmentally destructive subject, it is not so much the reiteration of an (old) colonial difference in (new) policy bottles that matters here. More important is excavating strategies of re-orientation of political frames through which to read and challenge the representations and discourses upon which they rest. Rather than seek these resistances outside a singular modernity, the challenge is to rework ethical professional knowledge production's engagement with Indigenous political ontologies in addition to critiquing the exclusionary forms of coloniality that are reworked continuously in globalised spaces (Briones 2011: 325).

5 Conclusions

If I started off with a discussion of environment, cultural-racial difference and knowledge that highlighted the most epistemologically/culturally 'distant' marker—that of female Indigenous knowledge—I then spiralled deliberately ever closer to the western neoliberal university and those of us who rely upon it for our income and status. In other words I have opened the remit to consider not only Indigenous knowledge but crucially the ways in which the boundary between Indigenous and geographical knowledge is scripted, performed and bolstered through epistemological and ontological formulations. My account differs from most of the geographical literature on postcolonialism to date (which rightly asks hard questions about researchers' practices of knowledge production) by examining the ways in which governmentality constitutes knowledge and the forms of its production. I have situated geography as a discipline within a postcolonial globalised arena of knowledge production in/outside the academy in which geographical scriptings of environment-cultural-racial difference and territory became bound up in forms of governmentality rooted in coloniality. In this terrain, it is insufficient to consider that Indigenous participation per se in research overcomes marginalisation. "Learning is a process of worlding … It is formed in the world, in the distanciated ecology of interactions between texts, people, sites and objects; and it is of the world, in its capacity to represent different people/sites" (Jazeel and McFarlane 2010: 115). Yet rather than consider this to be a process of switching certainty of facts, knowledge, ontologies, status (cf. Jazeel and McFarlane 2010),[23] I suggest two ways in which this unlearning of privilege might go. On the one hand, border dialogues with Other epistemologies can contribute to the scripting of modernity other-wise. Also the post-universalist agenda articulated in geography most forcefully by Kay Anderson contributes to an understanding of how socionatures are embroiled with postcolonial intra-human difference. Geography could also contribute much more to the postcolonial debates

[23] Specific "forms and uses of comparison that take a responsible ethic as their starting point, precisely by seeking to unsettle and destabilise the certitudes of knowledge and theory as it is produced through links across cultures of knowledge production and in the process seeks to develop new lines of inquiry" (Jazeel and McFarlane 2010: 118, 117).

concerning post-universalist ontologies, both in terms of how socionatures are produced and framed in epistemology but also in exploring the ways schemes to divide the bios range across human and non-human are now inextricably entangled with postcolonial distinctions between different types of human. To do so however would require geography to more systematically confront the ways in which the discipline has worked against the "viability and immediacy of knowledges and politics produced outside and against the dominant occidental discourses and on resisting monologic reasoning that shuts down political possibilities rather than opens them" (Schiwy and Ennis 2002: 11).

In geography, we need analytical frameworks that bring processes of knowledge production firmly into our analysis from a postcolonial perspective, recognising the diversity of knowledge productions taking place at multiple scales simultaneously. In short while taking seriously the project of decolonization and its associated knowledge productions, it is also imperative to take into account non-university professional knowledge production processes, and the existence of Indigenous political ontologies that challenge the way that we compartmentalise and understand knowledge and knowledgeable subjects. Keeping those two broad fields in mind differentiates me from the modernity-coloniality group of Walter Mignolo, Catherine Walsh et al. whose focus is primarily on forms of Other knowledge and border thinking. My argument is also distinctive to that of geographers—including Liz Bondi, Nina Laurie among others—who have yet to juxtapose their insightful analyses of professional knowledges alongside decolonization knowledge production in order to generate analysis Other-wise. My own position on this tension is hopefully clear, namely to engage a postcolonial critique of local and participatory modes of learning and their entanglement in metropolitan alternativism's geopolitics of knowledge.

Geographical writing on postcolonialism's consequences for the discipline highlights the problematic status of coloniality's universalist claims to truth. However a postcolonial caution against universalist claims risks missing a key switch in the modern register from universalism to Difference and the analytical challenge of how to deal with power founded on differentiated place-environment-racialized Others. If this switch away from universalism as coloniality's sign is indeed occurring, the tension between place-based knowledge and the abstractions required for disciplinary status is not necessarily a tension at the level of intra-disciplinary status (Jazeel and McFarlane 2010: 112, 113), but a tension with respect to the investment geography is increasingly called upon to make in metropolitan alternativism. Given the not inconsiderable pressures towards geography's re-positioning as a public "good"—that is, to apply its knowledge to the resolution of major environmental and human problems—the tension then erupts, giving rise to different geopolitics of knowledge production. Geographers' critical interrogations of place, space and terrain can take these insights much further than I have been able to do here, opening up accounts of the multilayered and embodied processes by which knowledges are made and circulated in material and imaginative geographies.

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No Going Back: The Political Ethics of Ecological Novelty

Paul Robbins

Abstract This chapter argues that ecological novelty, a condition where new species and mixes of species come to form persistent communities with no precedent, holds unavoidable implications for science. It argues that the "Edenic" sciences focusing on these ecologies—conservation biology, invasion biology/ecology, and restoration ecology—though extremely valuable, are inherently political. Though this has always been the case, the rapid changes in environments around us have made the political implications of these sciences harder to ignore or disguise. As such, these fields will necessarily need to evolve an ethical procedure to adjudicate between ecological interventions, rather than depending on restorative or originary criteria. Further, the evolution of these criteria and standards will be rooted in principles that come to terms with the political implications and character of scientists and scientific practice within broader diverse publics. Finally, scientific education will require the creation of a new set of standards for the instruction of ecological science, ones that better accept the role of anthropogenesis in ecological futures, and foster politically reflexive future scientists and citizens.

Keywords Environmental ethics • India • Invasive species • *Lantana camara* • Political ecology

> "…and the animals already know by instinct we're not comfortably at home in our translated world…"
>
> – Rainer Maria Rilke
> – Duino Elegies, First Elegy[1]

[1] Rilke (1977).

P. Robbins (✉)
Nelson Institute for Environmental Studies, University of Wisconsin–Madison, Science Hall, 550 North Park Street, Madison, WI 53705, USA
e-mail: director@nelson.wisc.edu

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1 Introduction

It is increasingly acknowledged by biologists and ecologists, both basic and applied, that while some ecological transitions occurring across the earth are reversible, a great many more may be permanent and may result in assemblages and structures without precedent (Hobbs et al. 2009). Though these new ecologies and ecosystems may be influenced to serve historic ecological functions, their qualities and characteristics will be the result of explicit or implicit human decision-making. In an era of novel ecologies there is, in this sense, "no going back." Future environments will be the result of human struggles over divergent priorities.

This chapter argues that these conditions hold further implications for adapting science to manage a transition towards sustainability. First, the "Edenic" sciences—conservation biology, invasion biology/ecology, and restoration ecology—are here shown to be extremely valuable but inherently political practices. Introducing the example of *Lantana camara* invasion, the chapter demonstrates the way these fields are entangled in the control of landscapes and the flow of value from those landscapes. Though this has always been the case, rapid recent environmental changes have made the political implications of these sciences harder to ignore or disguise. As such, these fields will need to evolve an ethical procedure to adjudicate between ecological interventions, rather than depending on restorative or originary criteria.

Further, the evolution of these criteria and standards will necessarily be rooted in principles that come to terms with the political implications and character of scientists and scientific practice within broader diverse publics. Finally, scientific education will require the creation of a new set of standards for the instruction of ecological science, ones that better accept the role of anthropogenesis in ecological futures, and foster politically reflexive future scientists and citizens.

2 The Illustrative Case of *L. Camara*

L. camara (Fig. 1) is an attractive, flowering ornamental plant introduced to South Asia sometime in the early twentieth century. A gardener's favorite, the plant is thick-rooted, rapid in growth, and fares well in rain or shine. Indigenous to the Caribbean and Mexico/Texas, the plant is most definitely "out of place" in monsoon Asia, though it competes aggressively in places as far flung as the desert northwest of Rajasthan India, the hilly Western Ghats of Karnataka, and the forested wildlife parks of Sri Lanka (Ranwala and Thushari 2012).

This startlingly widespread geography is a testimonial to its hardy and adaptive nature. Its seeds are quickly dispersed by birds and reptiles, leading to new colonization (Heleno et al. 2013). It coppices well, which means efforts to cut it back often result in the reverse: its quick recovery and spread. Models of its distribution under

Fig. 1 *Lantana camara* an invasive exotic plant that has found its way into protected areas all across the Indian subcontinent

realistic climate change scenarios show an ever-widening range of habitat for this aggressive plant (Taylor et al. 2012).

The impacts of these invasions have been largely identified as negative for conservation efforts, since Lantana competes against native species in dry forests (Sundaram and Hiremath 2012) and decreases available grazing by some desirable wildlife species (Ticktin et al. 2012). Scientists from around the region have dedicated some time and effort to develop natural insect predators to drive back the invasion (Visalakshy and Jayanth 1990), but repeated application of herbicides also remains a favored approach (Ferrell et al. 2012).

When I first encountered this plant in research examining conservation conflicts around a wildlife sanctuary in India, it was perhaps the *one* feature in the landscape that almost everyone could agree about; foresters complained about its damage to native plant diversity, herders were concerned about its impact on livestock grazing and as a possible toxic forage, farmers disliked its impact on their ability to collect other non-timber forest products (Robbins 2000, 2001; Robbins et al. 2007).

So it is quite remarkable that in the decade since, throughout India, this foreign invader, often described in apocalyptic terms by conservation officers, has domesticated itself in interesting ways. According to conservation scientist Shonil Bhagwat, though Lantana can be noxious (Bhagwat et al. 2012), there is evidence that people and wildlife have started to live with the weed.

Lantana provides thick understory for small mammals to hide away from their predators and creates nesting sites for birds that predators find hard to reach. It retains moisture in the soil supporting soil fauna. It yields nectar for insects and butterflies, fruits for small frugivorous birds, food for small mammals like civets. It would seem that these species have taken to living with the weed because it is the most abundant (and almost unstoppable) source of food. As for people, some of the

communities in South India have started to make wickerwork baskets and furniture out of Lantana—it takes a little bit of processing, but the furniture looks just like rare and valuable "Calamus" furniture (a depleting resource in tropical forests). The species has not only become part of new complex assemblages of plants and animals in several regions, it has begun to become part of complex ecosystem functions in its sites of invasion, creating new equilibiria, habitats, and unintended impacts (Ghisalberti 2000).

3 Novel Ecosystems: A Scientific and Political Puzzle

Nor is any of this especially new or unique to the invasion of Lantana. This invasion, like countless others around the world, is part of what many understand to be a radical change in global ecosystems: the rise of *novel ecosystems* (Hobbs et al. 2009). Following Bridgewater et al. (2011: p. 243), "novel ecosystems are assemblages of species that have not co-occurred historically; such ecosystems result directly and indirectly from human activities, are relatively stable, and occupy space alongside existing semi-natural or natural ecosystems".

There are a number of reasons that never-before-seen concatenations of species have emerged in recent years, only one of which is the ubiquity of species invasion owing to human transport and introductions. This effect has been notably coupled with the impact of climate change, which both opens and closes habitats for species and species assemblages. Further, the wholesale transformation of some landscapes by people (e.g. forest clearing, road-building, mining, etc.) opens the way for new species to interact and new systems to emerge.

Amongst the most dramatic examples of such ecosystems, urban and industrial landscapes represent wholly transformed conditions. As Lundholm and Richardson (2010) have noted, these landscapes are enormously diverse themselves, ranging from barren toxic plains and PCB-soaked soils to suburban lawns hosting Canada geese and urban canyons serving as new hunting grounds for Peregrine falcons.

Such ecosystems, because they have no precedent, are often in a state of change, and have unknown ecological impacts and value, represent a complex puzzle. Scientifically, they call for careful appraisal of emerging ecosystem function and new relationships amongst species and between species and their abiotic context. Ethically, it offers an even more serious challenge. Do we work to extirpate novelty or nurture it? What criteria might we use to inform such a decision?

Lindenmayer et al. (2008: p. 134) further ask: "when and where are novel ecosystems appropriate? What can we do about changes deemed inappropriate? When does the preservation of a novel ecosystem become a conservation concern? If a novel ecosystem is a dynamic entity, at which point might conservation interventions be warranted? How long does an ecosystem have to exist for it to be considered novel?" Without access to an original condition against which to

make a judgment, it would seem ecology has lost its "moral compass" for supporting decision-making.

Consider again the case of Lantana, in the context of the Kumbhalgarh conservation reserve in northern India, where Lantana first became a noticeable presence in the 1990s (Robbins 2000). By 2013, the plant had aggressively moved up hill slopes throughout the range, driving out native understory species, especially perennial grasses. The overall effect is to cause a critical decline in fodder available to both wild and domesticated herbivores. For some forms of grazing deer, for example, this invasion reduces their habitat range dramatically. Herders (illegally) using the reserve for the grazing of sheep and goats (in herd sizes as large as 800 or 1,000 animals), report a dramatic loss of available resources and have responded by grazing further and deeper in the sanctuary in their search for fodder (Robbins et al. 2009).

Some species, conversely, have thrived throughout the invasion, especially including Hanuman langur monkeys (*Presbytis entellus*) who have begun to feed on Lantana seeds and fruits. Panthers (*Panthera pardus*), moreover, heavily predate these monkeys, making Lantana an increasingly important part of the entire ecosystem. Populations of these two species increased 59 % and 52 % respectively, between 1991 and 2005, precisely the period of aggressive plant invasion (Waite et al. 2007). Those local human forest users who rely on the reserve only for fuelwood and construction materials similarly report no problems stemming from Lantana invasion, and some have begun to harvest the plant for economic uses. Lantana's invasion "biography" (Robbins 2004) has entangled it in new resource networks that benefit people and numerous other species, some of which are of conservation concern.

A decision to aggressively extirpate Lantana from the reserve, which requires the mobilization of significant resources (using intensive mechanical, cultural, chemical and biological methods), certainly benefits a number of human interests and species, especially those that depend heavily on the declining native ground cover. Herding castes in the region of Kumbhlagarh are by no means without significant political clout, it should be noted, and advocates for these groups have made control of invasive species an explicit part of their claim for forest rights, demanding the Forest Department work to "conserve the *original* grassland ecosystem" (Network 2010, my emphasis; Fig. 2). The Rajasthan state Forest Department has indeed favored control of invasives and mobilized herbicidal controls for Lantana (Kumar 2009), though for the explicit goal of preserving wildlife habitat. The language of control on the part of authorities, however, is also laced with urgency and rooted in the assumption that a restoration of *original* ecological conditions is self-evidently a normative good.

Conversely, however, Lantana's successful integration into Kumbhalgarh's ecosystem also suggests that interventions such as these come as a cost to their constituencies, ranging from the wildlife populations that have come to depend on the plants for food and nesting habitat to those locals who have adopted the plant for weaving and other economic purposes. The demand and deployment of state resources, conjoined with economic interests, ultimately adjudicates the strategy for addressing novel ecosystems, therefore, with "winners" and "losers" as a result.

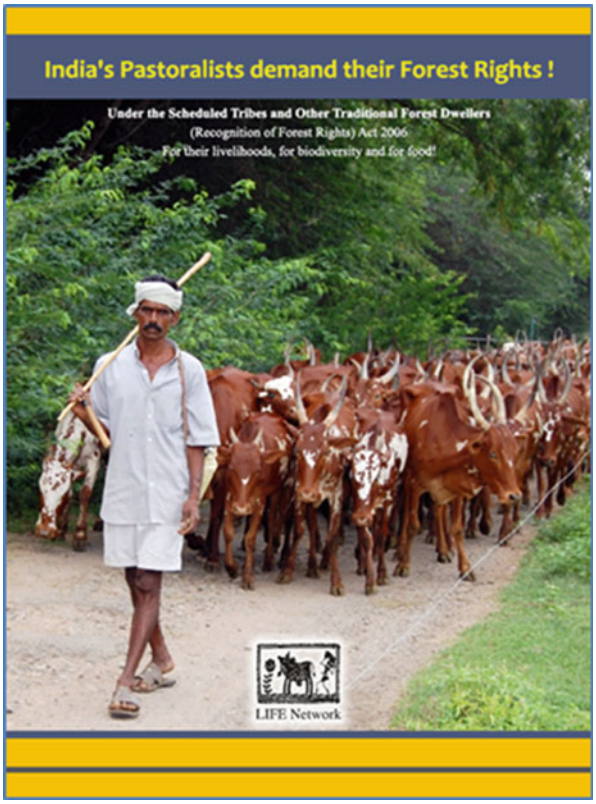

Fig. 2 Advocacy for herders in India has explicitly made demands for invasive species control a part of their claims on Forest Rights

Clearly then, answers to questions of how when and whether to intervene in novel ecologies can never be known a priori to be beneficial or problematic, as they are always part of a set of local social and ecological entanglements that produce highly specified effects, judgeable only in context. Moreover, such questions rarely benefit from unanimity of values and goals, so that any adjudication of whether to extirpate or nurture a species or assemblage must be the result of conflict and the application of material and discursive power, often exercised under condition of gross social, economic, and political asymmetries.

4 The Edenic Sciences as Political Sciences

This makes the practice of many kinds of scientific analysis and intervention starkly political. Amongst scientific fields most entangled with this problem, three stand out: conservation biology, restoration ecology, and invasion biology. Though quite different in goals and modes of analysis, these three fields all share a tacit commitment to returning transformed environments back to an earlier or previous state, one closer to "natural" conditions. As such, these together might be labeled "Edenic" sciences, in the sense that they seek a restoration of conditions "before the fall" (Robbins and Moore 2013). As such, each has its own political problem, made more troubling under conditions of ecological novelty.

Conservation biology is a scientific field rooted in an explicitly normative objective: to preserve and maintain the earth's biodiversity. Protecting species, habitats, and ecosystems is an assumed (and widely accepted) good. Though uncontroversial in a universal sense, this normative goal has implications for adjudicating other priorities, especially on a changing planet. Notably, it tends to encourage a strong position against non-native species, under any conditions. Because non-natives displace original habitat, species and diversity, conservation necessarily holds an a priori position on interventions into novel ecologies. This has been noted by some critics to lead to ecologically and economically irrational actions, especially large-scale mobilization of resources against species viewed as "out of place" (Davis et al. 2011). This is further entangled in the status of conservation as a political tool, since the concomitant authority of expertise that accompanies biology as a science adds additional weight to any struggle over decisions surrounding the nurturing or elimination of species. Conservation biology is a political science, in this sense.

Novel ecologies further complicate—or make more explicit—conservation's inherent politics. The effort to save species, which sits at the laudable core of the field and represents its *raison d'etre*, is one fraught with choices. As ecological change accelerates, should limited resources be poured into policing and defending a handful of the most important and iconic endangered species (e.g. the mountain gorilla) or spread across building new models and relationships with communities living around a greater diversity of life?[2] When conservation of species impinges on the lives and livelihoods of people, especially the world's poorest people, is there any point at which the use of conservation power is no longer defensible or justified (Robbins 2012; Brockington 2002)? What point is that?

Invasion biology and ecology are equally rooted in normative assumptions and hold political implications. As a science it spans that part of community and population biology and ecology that seeks to understand and explain the dispersal of species, their establishment and spread, and their impacts, but specifically focused on those species that enter an ecosystem from without, that "invade" (Davis 2009). Though such a field is, in specific terms, a descriptive and analytic perspective rather than a

[2] This choice was directly framed for me by a lead biologist working at a prominent global conservation organization just last year.

normative one, practitioners tend to heavily stress the urgency of the field precisely in terms of how *undesirable* invasions can be kept in check. More generally, the field is inherently conservative, since its associated management goal is to maintain historical ecosystems by stopping and reversing the impact of novel species and ecosystems.[3]

Similarly, though perhaps less problematically, the field of restoration ecology is a political one. This is because restoration is a both a basic scientific enterprise as well as an eminently practical one. Scientifically, restoration is a field that explores the way succession, inter-species interaction, and connections between soils, plants and non-plant organisms interact over time, especially when human actions—including planting, burning, "weed" control, soil remediation, or shifts in hydrology—influence ecosystems. The application of such ecological knowledge is geared towards turning undesirable landscapes, often ones whose biological potential has been severely impaired by people in the past, into ones with more desirable structure and function.

In restoration, the adjudication of what structure and function are "desirable" is, of course, a normative one. Traditionally, however, the mode of adjudication is to select a landscape from the past as a target towards which to aim restoration activities. The year 1491 is a typically selected date, since it is one before "New World" species were introduced to Europe and vice versa. Such a choice is necessarily arbitrary of course, since native people had already heavily influenced species mixes, ecological regimes, and diversity of New World landscapes, making this period no more "natural" than later eras. The selection of a target for restoration is also necessarily political, since the ecosystem benefits or services of one landscape inevitably meet the needs of some human communities better than others and, in many cases, what is a significant improvement for some is considered degradation by others.

This poses practical dilemmas. For example, where development activities have led to biodiversity decline, restorationists have been called upon to "restore" biodiversity elsewhere, essentially to design new landscapes that serve lost functions, resulting in no net loss of diversity overall. Here, the complexity of dynamic ecosystems and of relationships between native systems and novel/introduced species makes it nearly impossible to achieve and offset for previously lost diversity, drawing a number of policy assumptions into question (Maron et al. 2012).

Novel ecologies impact the politics of restoration in a number of ways. Chief among these, under rapid change, some ecological conditions are difficult or impossible to "return" from, for complex reasons associated with *hysteresis*, the non-linear relationships between some ecological states and transitions that make some of them ecological "one way trips" (Lockwood and Lockwood 1993; Westoby et al. 1989; Besiner et al. 2003; Hobbs 2007). Insofar as many novel ecologies are ones from which "restoration" to past conditions cannot be achieved, the useful baselines of the past become irrelevant, rendering more explicit the political nature

[3] Though the author was able to find rare cases where invasion science was directed towards accelerating the introduction and establishment of a non-native species. See Griffiths et al. (2010, 2011).

of the choices made by restorationists in their efforts. If the landscape is not going "back," and the role of the restorations is increasingly revealed to be one of *design* as much as recovery, then upon what basis are we to make choices about future environments?

In sum, ecological novelty has drawn attention to the underlying, anterior, and inevitable political status of ecological sciences dedicated to species preservation, invasion control, or restoration of landscapes. It has pointed specifically towards the way conservation, invasion, a restoration ecology and biology reflect sciences that exert power *over the landscape* as well as techniques through which power and value flow *from the landscape* to specific interests.

5 Evolving a Political Ethics for Novel Ecologies

With such power comes a great deal of responsibility. Are there guiding principles for defending specific decisions and adjudications? What are the ethics of novel ecologies?

Traditional ecological ethics, which provided so much value and utility for past conservationists, are surprisingly limited in their utility to answer such questions. As the philosopher Robert Kirkman (2002) has observed, this is because the rich tradition of environmental ethics has largely been focused on introducing non-anthropocentric principles to extend care and value to non-humans in, of, and for themselves. Its goal has been the foundation and appreciation of the "intrinsic value" of things.

5.1 Traditional Environmental Ethics

Kirkman points out that there is a wide diversity of ethical opinion around the basis and diversity of such value. Some ethicists assert that such value can only be known through a kind of "moral intuition" while others believe it can be appreciated and learned through observation. Even so, the core idea is that the value of non-humans might be weighed against the utilitarian value of things, especially their raw economic value.

The undeniable value of this ethical tradition lies in the way it allows human beings to present reasoned arguments for things beyond meager utility and defend the landscapes and species around them. Probably the most important and elegant formations of this argument is Aldo Leopold's "Land Ethic", which asserts the value of not only (or even) individual organisms or species, but instead whole interacting ecological systems and landscapes (Leopold 1949). For feminist environmentalists, this has the further value of producing an ethics of care, which changes human beings themselves, helping foster a different kind of social fabric, and a different way of being human (Warren 1996). This is potent stuff, which has had a terrific influence on many outcomes that lots of people consider valuable:

environmental policies like the Endangered Species Act in the Unites States, as well as the environmental movement in Europe and North America, writ large.

For Kirkman, however, there are flaws that lie at the heart of these ethics, problematic enough to limit their utility as a "moral compass" for making the kinds of choices and adjudications described previously: extirpating or preserving species, deciding between targets for preservation, and weighing human and non-human value. The largest of these flaws is that these forms of environmental ethics depend on an elision between facts and values, and a dependence on science as the resting place of ecological value.

Following Hume, Kirkman demonstrates that "a moral prescription (an 'ought') can never be derived logically from an empirical observation (an 'is')" Environmental philosophy "must necessarily appeal to some sort of description of the natural world to inform their ethical standards, and they often appeal to descriptions provided by the sciences" (Kirkman 2002). Just because something is, however, doesn't make it right.

Beyond the fundamental ethical flaw that this represents, it also presents a practical problem. As we have seen, scientific practice itself is already suffused with unconsidered and unacknowledged values and priorities. The circularity of this condition leads only to the reinforcement of arbitrary assumptions.

This failure is made all the more problematic under conditions where scientists have called into question some of the observed characteristics or qualities under which natural systems are understood to be "natural". Most notable of these has been the abandonment of equilibrium as a universal condition of ecological system state, and therefore one that might be viewed as natural, and by implication desirable (Foin and Davis 1987; Behnke and Scoones 1993; Illius and O'Connor 1999; Zimmerer 2000; Sayre 2012). While some systems exhibit equilibrium, others do not, and such a state makes a poor foundation, therefore, for any given condition to be ethically valued over another.

Kirkman also points out that traditional environmental ethics performs poorly when it attempts to confront and convince people for whom core foundations of value may not align with those of the environmentalist. Hypothetically, for example, someone who fundamentally values tidiness over naturalness is likely to prefer a manicured lawn to a forest, with little in the ethicist's playbook to compel a conversion (p. 145). This is again made all the more complicated by the declining ability, under conditions of ecological novelty, of scientists to reinforce the ethicist's proposition that one environmental state is more "natural" than another. Predicated entirely on seeking to cause a sea-change in *everyone's* values and rooted in the certainty that ecological science can map out what conditions are to be *valued*, environmental philosophy has made itself somewhat (and unnecessarily) unconvincing.

5.2 Beyond Traditional Ethics

Together these flaws suggest that the highly political decisions made within and around ecological novelty and its associated sciences are not satisfactorily

adjudicated through traditional environmental ethics. This is not to say that species are not disappearing at an alarming rate, that the globe is not warming, or that there are not exposures to toxins and hazards that proliferate from contemporary society and economy. Rather it is to invite a reappraisal of the ethical standards we use to sort through our specific choices and confront the political and contentious nature of those choices.

As noted previously, the hard truth of the Edenic Sciences is that they are vehicles to both exert power over the environment and to allow the flow of value from the landscape to specific interests. If we restore a New England landscape to conditions of the year 1891, before a subdivision was built, we might produce a grassland, with obvious losses and gains for those who value houses versus those who value native raptors and grazing land. If we restored it to the year 1491, we might find ourselves with a mixed forest, controlled by native burning, a choice that would trade-off the whole range of valuable grassland species in favor of woodland species desired by Indian hunters. Such struggles were embodied in the violent colonial and industrial encounters that changed landscapes in the first place (Cronon 1983), and would be entailed in any effort change them "back". Put simply then, these changes represent *conflicts* between humans or groups of humans.

This does not mean that these conflicts are merely struggles between anthropocentrism or ecocentrism. It is possible to imagine, for example, two ecocentric groups struggling with one another to choose between specific species to spare, restore, or extirpate, just as one might imagine two utilitarian communities fighting over whose economic values are best served by developing or sparing a landscape. In either case, environmental change and uncertainty make such decisions all the more complicated and no less certain.

Nor does this mean that all interests involved in these struggles are equally well-positioned or empowered in some kind of pluralistic decision-making process. The destruction of native hunting forests, followed by the destruction of grazing prairie noted above—a common transition in New England during modernization—was an embodied instantiation of violent power, with white settlers annihilating both native landscapes and people in the first iteration, only to be overpowered by an industrial economy that would sweep away agriculture thereafter. These transitions were political, messy, and often violent—these are all self-evidently *political ecologies*.

The admission of this, Kirkman suggests, actually provides us with an ethical way forward, suggesting that we step away from a philosophy in which first principles (typically derived from desired outcomes known-in-advance) guide our determinations. In their place an observer (philosopher, scientist, or citizen) "should get involved with the concrete details of environmental problems in all their complexity and gain a clear understanding of the full range of values that are in dispute; only then should he or she move towards more general principles in the process of building consensus on policy or practices" (Kirkman 2002).

It might be added, moreover, that any such involvement with concrete and complex details of environmental problems will entail encounters with divided political communities and actors struggling over divergent outcomes, with many of these, as noted before, outmatched by powerful, persuasive, capitalized, and often-violent

adversaries. We must acknowledge that once the antiseptic comfort of knowing what is right in advance dissolves, scientists and philosophers will be wading into fights where they may find both powerful allies and enemies. This does not mean that they will be unable to serve a useful and powerful role in reaching new kinds of consensus, helping come to peaceful, just and sustainable outcomes by means of science, logic, and foundational principles.

It simply means that it is going to be messy.

6 Revisiting Political Ethics of Ecological Novelty

In this chapter, I have suggested so far that ecological novelty is ongoing and accelerating, that it exposes some pre-existing ethical and political challenges for ecological sciences, that traditional ecological ethics is not perfectly suited to sorting out these issues, and that a more honestly political ethics is required to make science a relevant part of decision-making in the Anthropocene. Local, entangled politics require rigorous ecological and ethical assessment, and an admission on the part of scientists that they will be engaging divided communities.

There is little in the training of scientists, or of citizens in science, that suggests these entanglements, it should be noted. Introductory textbooks, for example, though increasingly explicit about the policy issues that surround basic science, provide few sign posts for practitioners or students. Such texts address the confounding issues in one of at least three ways, which might be called: "just the facts"; "science studies, you decide", and "start from your principles".

Books like Darell Hess' *McKnight's Physical Geography* (2014, now in its 11th edition) approach ecological change from a "just the facts" perspective, carefully defining concepts like exotic species, and using case examples like the Burmese python and walking catfish in Florida to illustrate how successful invasions occur. This apparently neutral approach is compelling, since it appears to allow budding scientists to think, on their own terms, about the implications of environmental change. There is no chapter, notably, on environmental decision-making, ethics, or politics. Tacit throughout any such *apolitical* text, however, is a deeply normative dedication to documenting anthropogenic degradation. Each chapter in this text includes a nicely produced and well-written breakout box on "people and the environment", each of which, without exception paints a picture of destruction: the Pacific Garbage Patch, the Deepwater Horizon Spill, or Rainforest Decline in Brazil.

The discussion of all of these urgent environmental problems is unobjectionable, of course, and students remain ignorant of them at great peril. But in the absence of any textual support on how scientists, firms, governments, and citizens interact to cause, address, or debate these problems, the tacit conclusion must be that people—separate from nature—are something of a cancer on the Earth, whose appropriate condition is that in which humans are absent. "Just the facts" silently contains a traditional ecocentric ethic and an attendant apolitical problem, for those seeking to imagine a way forward.

This is quite different from a training model that stresses the role of science in informing an external debate. Travis Hudson's text, *Living with Earth* (2011), provides a compelling example. This approach differs from that of "just the facts" in significant ways, including a more immersive orientation to people and the planet (implied in the challenging title of Hudson's text itself). In the book's concluding policy chapter, a well-explained case example of successful consensus-building at a platinum and palladium mine site in Montana is used to illustrate that strong regulatory authority, good science, and well-meaning people can come together to solve problems without adversarial litigation, using consensus agreement. This "science studies, you decide" approach is further reinforced by the book's strong concluding assertion: "Everyone is a stakeholder when it comes to balancing the needs of people and those of the environment" (p. 489).

The ethics of this approach are also traditional, in the sense that they posit an ecocentric approach to the world "balanced" against an anthropocentric one, without acknowledgment that valuing the environment itself is an elusive goal even for ecocentrics. This is coupled with a remarkably egalitarian and pluralistic vision of environmental conflicts; important pieces of environmental legislation are defined and introduced, but none of the divisive struggles that led to their enactment, Finally, it is one that explicitly separates science and the priorities and conflicts upon which science impinges. "These decisions will benefit from the understanding and technology that science and engineering bring to them, but in the end it will be up to people like you to decide". "People like you", the reader, are clearly not supposed to be scientists, or at least not making ethical or political decisions when they are doing science. The pre-existing ethical positions inherent in specific sciences are also unobserved.

More explicitly focused on ethics, a third approach to training in the Anthropocene points towards how primary and foundational principles can guide in making "tradeoffs". This Approach is embodied in Norm Christensen's (2013) text the *Environment and You*, which includes an extremely compelling concluding section on environmental leadership. Here, the reader is encouraged to "Articulate a Vision Based on Your Values". This section directs the student to imagine scenarios where hard tradeoffs between the environment and the economy must be made. Here, they are told: "decisions about appropriate goals and actions are guided by ethical principles or values" (p. 628). The text further stresses that most tradeoffs are not clear cut, though some "win–win" outcomes can be found as well. Far more directed to developing ethical thinking, this approach signals that principles and decisions are bound up with science in an exciting and refreshing way.

This approach again problematically rests on traditional environmental ethics, however, which stress that "ecocentrism versus anthropocentrism" sits at the heart of environmental problems. In a dynamic Anthropocene environmental context, different kinds of ecocentrism will no doubt contend, raising questions about the assumptions upon which "your values" might rest. Little emphasis here, moreover, is placed on the political character of these ethical decisions, and the differential stakes of their resolution. In the place of winners and losers are phrases invoking the collective "we": the cost of "all our activities… have environmental costs". This reinforcement is coupled by the insistence that values can be

unproblematically known in advance, rather than revealed in difficult contestations over competing claims.

These approaches to science and society are of course merely the ones we find in introductory textbooks, and so make only weak indicators of the status of scientific discourse in diverse fields. Nonetheless, strong assumptions are often revealed in the pattern of pedagogy, and the ethical and political challenges of novelty are largely unremarked in these typical texts. In this sense, they map an arc of evasion outlined in this chapter, which continues to dodge core questions we confront in the Anthropocene. The next generation of scientists and citizens would be better served by a more honest confrontation. Such an evasion is as unnecessary as it is unfortunate, moreover, because teaching– and thinking—about new conditions and trajectories provides an opportunity to productively interrogate our priorities and engage a wider public about what is desirable and undesirable about environmental change.

This returns us to the challenges I reviewed at the outset, which include making decisions about unprecedented ecological assemblages and, even more fraught with uncertainty, advancing scientific research historically focused on retreating from such novelty. It seems increasingly clear that confronting these new conditions will entail an encounter between researchers and the political and ethical underpinnings of their disciplines. But if the three approaches outlined above ("just the facts"; "science studies, you decide", and "start from your principles") are abandoned in favor of a more engaged political ethics, the Edenic Sciences are poised to become *leaders* in research and decision-making. This is because these fields—conservation, restoration, and invasion—contain the core conceptual and apparatuses, methodologies, and insights necessary to cope with novelty. Conservation biology gives unique insight into interspecific hierarchies and relationships. Restoration ecology sheds light on how soil, hydrology, and new mixes of species impinge on one another. Invasion ecology and biology address succession, mutualism, and complex tipping points. All of these conceptual tools are essential to our productive entanglements with novel ecologies.

These fields may therefore earn new names, as where the term "restoration ecology" may give way to "ecological design" in a changing world where there is no going back. But the ambiguous collective signature of these fields, an elision of political advocacy, scientific rigor, and ethical norms, will continue to be unmistakable and irreplaceable as we confront new species, landscapes, and biogeographies in the next century.

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The 2011 Great East Japan Earthquake Disaster

Kenji Satake

Abstract The 2011 Tohoku earthquake (magnitude 9.0), the largest earthquake in Japanese history, resulted in devastating tsunami damage and the partial destruction of the Fukushima Dai-ichi nuclear power station. Extensive seafloor displacement and slip on the shallow plate interface of the Pacific Plate near the Japan Trench axis have been revealed from the land-based GPS network and marine geodetic observation systems. The generation and propagation of the tsunami were also recorded on offshore bottom pressure and GPS wave gauges, prior to its arrival at the coast. Long-term earthquake forecasts, based on the recurrence of past large earthquakes, failed to foresee this giant earthquake. However, in retrospect, the historical record and recent paleoseismological studies indicate that tsunamis with similar characteristics occurred on the Sanriku coast in 1896 and on the Sendai plain in 869. Analysis of the 2011 tsunami waveforms clarifies that the tsunami source was a combination of the 1896-type "tsunami earthquake" and the 869-type earthquake on the deeper plate interface.

Keywords 2011 Tohoku earthquake • Great East Japan earthquake disaster • Jogan • Sanriku • Tsunami

1 Introduction

The 11 March 2011 Tohoku earthquake (which is officially referred to by the Japan Meteorological Agency (JMA) as the 2011 off the Pacific coast of Tohoku Earthquake) was the largest (magnitude $M = 9.0$) in Japanese history. Strong ground

K. Satake (✉)
Earthquake Research Institute, The University of Tokyo, 1-1-1 Yayoi, Bunky-ku, Tokyo 113-0032, Japan
e-mail: satake@eri.u-tokyo.ac.jp

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motion was widely felt in eastern Japan. The associated tsunami rose as high as nearly 40 m on the Sanriku coast with a maximum inland penetration of nearly 5 km in the Sendai plain. The earthquake ground shaking and tsunami caused devastating damage with nearly 20,000 casualties; most of the fatalities were from drowning in the tsunami. The disaster, which included the Fukushima Dai-ichi nuclear power station accident, has been officially named the Great Eastern Japan Earthquake disaster by the Japanese Cabinet.

The Tohoku earthquake occurred along the Japan Trench, where the Pacific Plate is subducting beneath northern Japan. After the 1995 Kobe earthquake ($M=7.3$), which caused devastating damage, including 6,500 casualties, the Japanese government installed nation-wide seismic and geodetic networks. In addition to these land-based dense networks, marine geophysical measurements that started before the 2011 Tohoku earthquake revealed extensive seafloor displacement. These unique observations will be briefly introduced in Sect. 2.

The Japanese government had previously released a long-term forecast of earthquakes in and around Japan. For example, off the Miyagi prefecture, near the epicenter of the Tohoku earthquake, the probability of a $M\sim7.5$ earthquake in the next 30 years had been estimated as 99 %. The 2011 earthquake, however, was much larger than forecasts, both in magnitude and source area. The background and reasons for this failure in forecasting will be discussed in Sect. 3.

The devastating tsunami of the Tohoku earthquake was first recorded offshore, before it arrived at the coast. Field surveys have revealed that the maximum tsunami height was nearly 40 m on the Sanriku coast. A tsunami warning was issued based on the seismological data, but forecast water heights were lower than the actual heights because of the initial underestimation of the earthquake magnitude. The tsunami observations and warning will be discussed in Sect. 4.

The Sanriku coast had been devastated by previous tsunamis. The 1896 Sanriku earthquake caused a large tsunami, with a maximum height of 38 m, similar to the 2011 tsunami, and resulted in about 22,000 casualties, slightly more than the 2011 tsunami. In 1933, another Sanriku earthquake caused about 3,000 casualties. In 1960, a tsunami from the Chilean earthquake again devastated the Sanriku coast. To the south in the Sendai plain, a large earthquake and tsunami event in AD 869 during the Jogan era is recorded in a national history book. Recent geological studies have found physical evidence of the tsunami, in the form of tsunami deposits distributed in the plain. These past tsunamis will be described in Sect. 5.

Analysis of tsunami waveforms recorded by offshore instruments combined with computer simulation of the tsunami clarifies details of the 2011 tsunami source. The analysis shows that the 2011 earthquake was a combination of 1896-type and 869-type earthquakes. Although the occurrence of each type, a “tsunami earthquake” and a deeper interplate earthquake, had been known, a combination or simultaneous occurrence of the two types was not known or considered in the previous tsunami hazard assessment. The analysis and implication of these results will be discussed in Sect. 6.

2 The Earthquake

2.1 Land-Based Observations

The earthquake source parameters provided by JMA include: the epicenter at 38°06.2′N, 142°51.6′E, a focal depth of 24 km, a magnitude of *M* 9.0, and an origin time of 14:46:18.1 JST (GMT+9 h). The focal mechanism (strike: 193°, dip angle: 10°, slip angle: 79°) shows typical underthrust faulting associated with the subduction of the Pacific Plate beneath the Tohoku region. The subduction rate of the Pacific Plate in this region is approximately 8 cm per year.

The earthquake was felt in most of the Japanese islands (Fig. 1), with the largest seismic intensity of 7 (the highest) on the JMA's seismic intensity scale (corresponding to 11 or 12 on the Modified Mercalli scale). Seismic intensity, which was originally estimated by human or damage distribution, is now assigned by densely distributed instruments. The size of the earthquake, or magnitude *M*, inferred from a standard method using short-period seismic records, is only 8.4, much smaller than $M=9.0$ estimated from long-period seismic waves or other data described below.

A large crustal displacement was recorded by the land-based GPS (Global Positioning System) network. The Geospatial Information Authority of Japan (GSI)

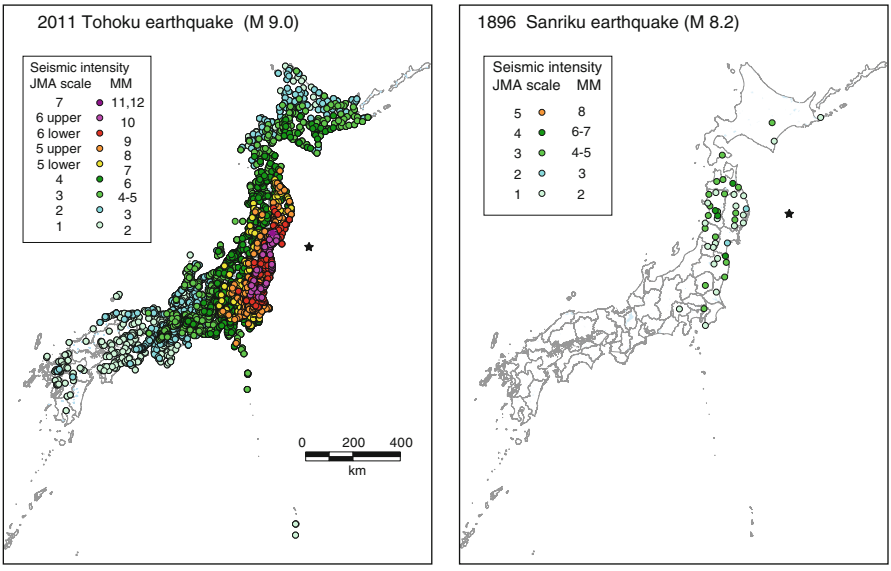

Fig. 1 Seismic intensity distributions of the 2011 Tohoku earthquake (*left*) and the 1896 Sanriku earthquake (*right*). The intensity is on the Japan Meteorological Agency (JMA) scale, but corresponding values for the Modified Mercalli (MM) scale are also shown. The original data are from JMA and Omori (1901). The epicenters are shown by *black stars*. The magnitude values are those assigned by JMA

has deployed a nation-wide GPS network consisting of approximately 1,200 stations. Before the Tohoku earthquake, subduction of the Pacific Plate caused a westward movement and east–west compression of northern Honshu. At the time of the 2011 Tohoku earthquake, the GPS network recorded an eastward movement with a maximum of 5.3 m and subsidence of up to 1.2 m of the Pacific coast of Tohoku region (Ozawa et al. 2011).

The 2011 Tohoku earthquake source has been modeled using these land-based geophysical data, including seismic waves and GPS data. These studies show that the seismic moment, corresponding to the physical size of the fault motion, is approximately 4×10^{22} Nm. The corresponding magnitude, called moment magnitude *M*w, is 9.0. A large slip, up to a few tens of meters, was inferred on the plate boundary located beneath the seafloor. The details, such as the exact location and the amount of resultant seafloor displacement, however, were not confirmed by the land-based observations.

2.2 Seafloor Displacement Inferred from Submarine Observations

Marine geophysical measurements that started before the 2011 Tohoku earthquake detected large seafloor displacement and offshore tsunamis. These include repeat marine geodetic measurements using onboard GPS and acoustic signals (GPS/A), bottom pressure gauges to measure vertical seafloor displacement and tsunami propagation, and repeat multi-beam sonar soundings to record sea depth change.

The repeat GPS/A measurements, which started several years before the 2011 Tohoku earthquake, revealed that the seafloor near the epicenter moved as much as 31 m horizontally and 3 m vertically (Fig. 2; Kido et al. 2011; Sato et al. 2011). The off-line bottom pressure gauges also recorded horizontal displacements of up to 60 m and vertical displacements of up to 5 m (Ito et al. 2011). Repeat multi-beam sonar soundings indicated that seafloor moved almost 50 m horizontally near the trench axis (Fujiwara et al. 2011). This is the greatest seafloor movement ever observed in the world.

These observations indicate that a very large (approximately 50 m) slip occurred on the shallow plate interface near the trench axis. This was a surprising result to many geophysicists, because the shallow plate interface near the trench axis had been considered to be weakly coupled and unable to accumulate strain. Large interplate earthquakes occur at seismogenic zones, typically at a depth range of 10–50 km, where the plate interface is strongly coupled.

The above observations of the size and seafloor displacement of this giant earthquake could not have been detected without modern geophysical observations. This implies that similar gigantic earthquakes in the past could have been missed in the historical literature, which generally describes damage in the context of ground shaking and tsunamis.

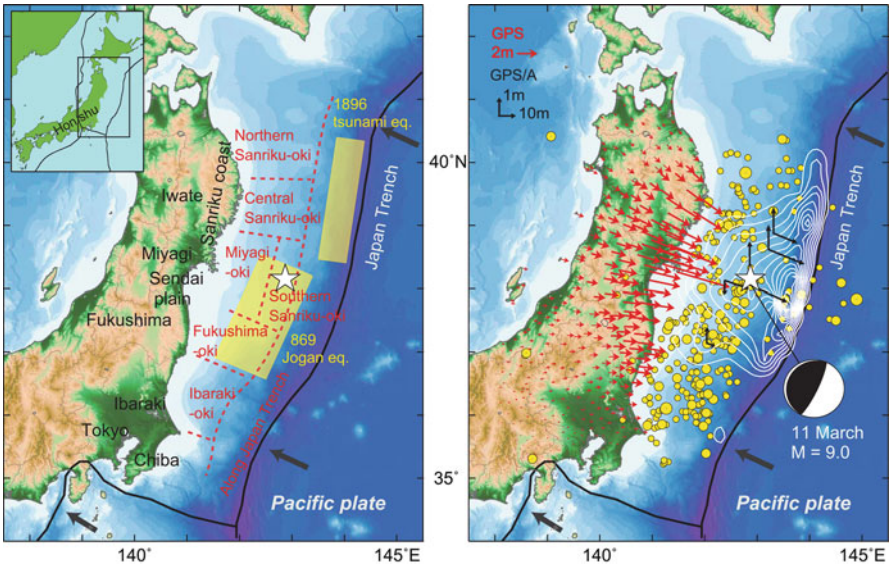

Fig. 2 The source region of the 2011 Tohoku earthquake (the epicenter is shown by the *white star*). The plate boundaries and the relative motions are shown by *black curves* and *arrows*. (*Left*) The regions for long-term forecast (*red dashed lines*, Earthquake Research Committee 2009) and the proposed fault models (*yellow rectangles*) of the 1896 Sanriku earthquake (Tanioka and Satake 1996) and the 869 Jogan earthquake (Satake et al. 2008) are shown. (*Right*) The focal mechanism solution (*beach ball*) of the mainshock and the locations of earthquakes with $M \geq 5.0$ (according to JMA) occurred within a week (*yellow circles*) are shown. The slip distribution estimated from the tsunami waveforms is shown by *white contours* with a 4 m interval (Satake et al. 2013). Coseismic movements of land-based GPS stations (*red arrows*, Ozawa et al. 2011) and marine GPS/acoustic measurements (*black arrows*, Sato et al. 2011) are also shown

3 Long-Term Forecast of Large Earthquakes in Japan

Could such a gigantic earthquake have been foreseen around Japan? Since the 1995 Kobe earthquake, the Japanese government has made long-term forecasts of large earthquakes in and around Japan based on past earthquake records, and published national seismic hazard maps (Earthquake Research Committee 2006). Probabilities of future earthquakes (e.g., in the next 30 years) are calculated from the past data of large earthquakes by fitting inter-earthquake times with a probabilistic density function. If similarly sized earthquakes (referred to as characteristic earthquakes) recur regularly, and the average recurrence interval and dates of most recent events are known, a renewal process model such as a Brownian Passage Time model (Matthews et al. 2002) can be used to calculate time-dependent probabilities. In this case, the probability increases with time toward the next earthquake. If past data indicate that the temporal

distribution is random, or if the available data are not sufficient to show regularity, a Poisson process is assumed to compute the time-independent probabilities.

Off Miyagi prefecture (the Miyagi-oki region), to the west of the 2011 Tohoku earthquake epicenter, the probability of a great ($M \sim 7.5$) earthquake occurrence between 2010 and 2040 was estimated as 99 % (Earthquake Research Committee 2009). This estimate was based on the facts that large ($M \sim 7.4$) earthquakes have repeatedly occurred there with an average interval of 37 years since 1793, and that 32 years had passed since the last earthquake occurred in 1978. Just to the east, in the central Sanriku-oki region, where the 2011 epicenter is located, the 30 year probability of an earthquake with $M \sim 7.7$ was estimated as 80–90 %. The forecast also stated that if an earthquake ruptures these two regions simultaneously, the earthquake size would be $M \sim 8.0$. To the north, in the central Sanriku-oki region, no large earthquake occurrence was known; hence, the probability of a future event could not be calculated. To the south, off Fukushima prefecture (Fukushima-oki), a swarm of activity, with the largest earthquake having a magnitude of $M = 7.5$, was recorded in 1938. Assuming that these were the only large earthquakes since the 1600s, when historical records started in the region, the 30 year probability of an earthquake of $M \sim 7.4$ was estimated as <7 %.

Along the Japan Trench, long-term forecasts are made for two types of earthquakes, "tsunami earthquakes" and normal-fault earthquakes. A "tsunami earthquake" refers to an earthquake with relatively minor ground shaking but a very large associated tsunami (Kanamori 1972). As will be described in Sect. 5, the 1896 Sanriku earthquake is typical of a "tsunami earthquake." The 30-year probability of a tsunami earthquake with M_t 8.2 (a magnitude indicative of the tsunami size) was estimated as 20 %, based on the past history of three "tsunami earthquakes" recorded in 1611, 1677 and 1896 somewhere along the Japan Trench. A normal-fault earthquake occurs outside the trench axis, often called the outer-rise region. The 1933 Sanriku earthquake (M 8.1) was the only known great normal-fault earthquake (Kanamori 1971), and the 30-year probability of similar earthquake was estimated as 4–7 % along the Japan Trench.

The 2011 Tohoku earthquake was much larger than the forecasts, both in magnitude and source area. The rupture started in the southern Sanriku region but propagated into neighboring regions. The source area was about 500 km long and 200 km wide, including the central Sanriku, Miyagi-oki, southern Sanriku, and Fukushima-oki regions, and parts of the Ibaraki-oki region and the region along the Japan Trench (Fig. 2). The long-term forecast thus failed to predict the size (M) and the source region of the 2011 Tohoku earthquake. The long-term forecast was based on past earthquake records, but the occurrence of such a giant ($M \sim 9$) earthquake was not recorded in Japan, except for the 869 Jogan earthquake, which will be discussed in Sect. 5. After the 2011 Tohoku earthquake, the Earthquake Research Committee (2011) tentatively revised the long-term forecast, including the Tohoku earthquake.

4 The Tsunami

4.1 Offshore Tsunami Data

The 2011 tsunami was first recorded at offshore gauges (Fig. 3). At ocean bottom pressure gauge TM1, which is located about 76 km off the Sanriku coast at a water depth of 1,600 m and connected with a seafloor cable, a water rise of ~2 m was

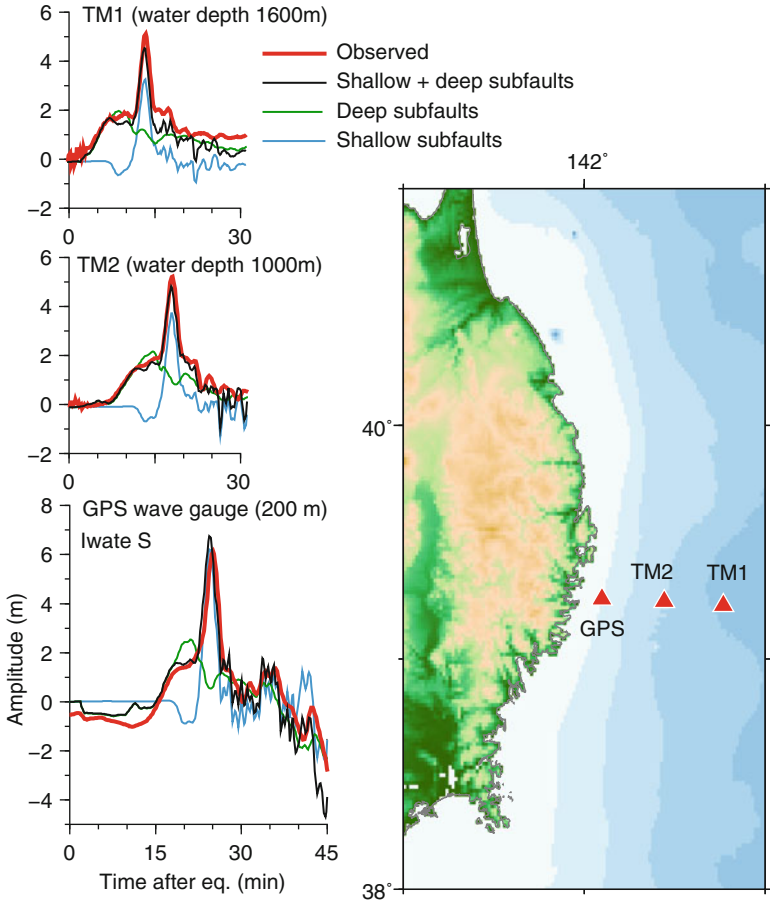

Fig. 3 Tsunami waveforms recorded at offshore bottom pressure gauges (TM1, TM2) and GPS wave gauge (based on Fujii et al. 2011). The locations of the gauges are shown in the right map. The *red curves* are the observed waveforms, the *black curves* are the synthetic waveforms from the tsunami source model, both shallow and deep faults. The *green* and *blue curves* are computed waveforms from the deep and shallow subfaults, respectively

recorded immediately after the earthquake, followed by an impulsive wave with additional 3 m rise within 2 min (Fujii et al. 2011). At TM2, located about 47 km from the coast in 1,000 m of water, a very similar two-stage tsunami waveform was recorded from 7 min after the earthquake. At a nearshore GPS wave gauge, located about 10 km offshore at a water depth of 200 m, a similar tsunami waveform with larger amplitudes was recorded from 12 min after the earthquake. The tsunami arrival on the coast was recorded on a tide gauge at the port of Kamaishi from about 30 min after the earthquake, but the large tsunami destroyed the system so the maximum amplitude was not recorded. The offshore tsunami generation and propagation toward the Sanriku coast were thus recorded on the offshore bottom pressure and GPS wave gauges, and the data were sent to JMA in real time and used to update the tsunami warning.

The tsunami was also recorded by deep ocean bottom tsunami gauges (the Deep-ocean Assessment and Recording of Tsunami, or DART system operated by US NOAA and other agencies) and coastal gauges around the Pacific Ocean. The maximum trough-to-crest tsunami heights were 3–4 m on the west coast of the USA and the southern Chilean coast. The tsunami caused two fatalities outside Japan: one in the USA and the other in Indonesia.

4.2 Coastal Tsunami Heights

The coastal tsunami heights on the Japanese coast were measured by the Joint Survey Group, consisting of ~300 researchers from more than 60 organizations, with the total number of measurement points exceeding 5,900 (Mori et al. 2011; Tsuji et al. 2011). The largest tsunami height was nearly 40 m, recorded near Miyako, at around 39.8°N (Fig. 4). Tsunami heights varied locally on the sawtooth-shaped Sanriku coast, but were generally larger on the northern Sanriku coast, north of 39.5°N. On the southern Sanriku coast, the maximum heights were up to 20 m, despite its closer proximity to the epicenter.

The tsunami also inundated coastal regions such as the Sendai plain, with the maximum inundation distance as great as 5 km. The total area of the 2011 tsunami inundation was estimated by the Geospatial Information Authority of Japan as 561 km^2, a region with a population of about 600,000.

4.3 The Tsunami Warning

The JMA issued a tsunami warning at 14:49, 3 min after the earthquake. The JMA's tsunami warning system consists of three categories: major tsunami warning (estimated tsunami height >3 m), tsunami warning (1 m<tsunami height<3 m), and tsunami advisory (0.2 m<height<1 m). The estimated tsunami heights for the Tohoku tsunami were 6 m on the Miyagi coast, 3 m on the Fukushima and Iwate

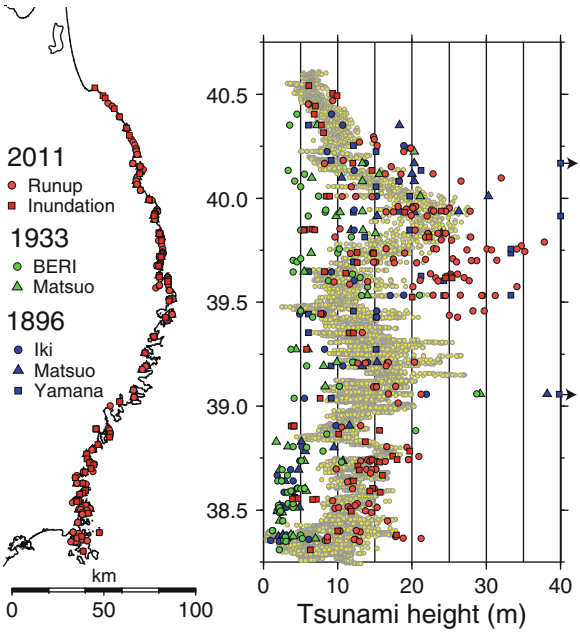

Fig. 4 Tsunami heights on the coast from the 2011 Tohoku earthquake (Tsuji et al. 2011), the 1933 Sanriku earthquake (reported by Earthquake Research Institute 1934; Matsuo 1933) and the 1896 Sanriku earthquake (Iki 1897; Matsuo 1933; Yamana reported in Unohana and Ota 1988). The *gray circles* are the computed tsunami heights from the 2011 Tohoku earthquake (Satake et al. 2013)

coasts, 2 m on the Ibaraki coast and the Pacific coast of Chiba, and 1 m on the Pacific coasts of Hokkaido, Aomori and Izu islands (Ozaki 2011). These were based on the initial estimate of the earthquake magnitude ($M=7.9$) and numerical simulations of tsunami stored in a database. Because the initial magnitude estimate was much smaller than the actual earthquake size ($M=9.0$), the levels of tsunami warning and the estimated tsunami heights were underestimated. Nevertheless, very strong ground shaking and the rapid tsunami warning urged many coastal residents to evacuate to high ground and thus saved their lives.

After detecting the large offshore tsunami on the GPS wave gauges, JMA upgraded the tsunami warning messages at 15:14 (28 min after the earthquake but before the tsunami arrival on coast) to higher levels of estimated tsunami heights. Tsunami warning messages were further updated at 15:30, and several times later on. However, the updated tsunami warning messages did not reach all coastal communities because of power failures and the fact that many people had already started evacuation.

5 Past Tsunamis on the Tohoku Coast

The Sanriku coast and the Sendai plain have been devastated by previous tsunamis. In this section, these tsunamis are described in a reverse chronological order.

5.1 The 1960 Chile Tsunami

The largest ($M=9.5$) earthquake in the twentieth century occurred offshore from southern Chile on 22 May 1960. The tsunami caused damage on the Chilean coast, including more than 1,000 casualties, then reached Hawaii in about 15 h after the earthquake and took 61 lives. About 23 h after the earthquake, the tsunami reached Japan. The tsunami heights on the Sanriku coast were up to 6 m, resulting in the deaths of 62 and 54 people in Iwate and Miyagi prefectures, respectively. On the Sanriku coast, some bays have a size and shape with a characteristic period that coincided with the predominant period (about 1 h) of the trans-Pacific tsunami. For example, the tsunami height was about 1 m near the entrance of Miyako Bay, but more than 5 m at the most inland part of the bay. After the 1960 Chilean tsunami, many breakwaters were constructed along the Sanriku coast, typically with heights of 6 m.

5.2 The 1933 Showa Sanriku Tsunami

The 1933 Sanriku earthquake caused a large tsunami, with heights up to 24 m but mostly between 5 and 10 m (Fig. 4) on the Sanriku coast, which caused about 3,000 casualties. While it occurred at night, unlike the 2011 or 1896 tsunamis, many people were able to escape to high ground to survive. This earthquake, which occurred on the eastern, or outer-rise, side of the Japan Trench, had a normal-fault mechanism (Kanamori 1971). Although the earthquake magnitude was large ($M=8.1$), the tsunami heights were not as large as the 2011 or 1896 tsunami, partially because of the distance from the coast. The large tsunami, damage and casualties were limited to the Sanriku coast.

5.3 The 1896 Meiji Sanriku Tsunami

The 1896 Sanriku earthquake caused a very large tsunami, with a maximum height of 38 m, similar to the 2011 Tohoku earthquake tsunami (Fig. 4). The 1896 tsunami caused about 22,000 casualties, somewhat more than the 2011 tsunami, but mostly limited to Iwate prefecture. At some villages on the Sanriku coast, more than 1,000 residents (about half the population) lost their lives. One notable feature of this tsunami was that the preceding earthquake shaking was very weak. Ground shaking was felt only in eastern Japan, with a maximum seismic intensity of 4 on the JMA scale at a few locations (Fig. 1). This was a typical "tsunami earthquake" (Kanamori 1972), and the magnitude is calculated as $M=7.2$ when only seismic waves are used; however, it becomes $M_t=8.2$–8.6 if the tsunami waves are used (Tanioka and Satake 1996). A study of the tsunami waveforms indicates that the 1896 earthquake was generated from fault motion near the trench axis (Tanioka and Satake 1996). The large tsunami, damage and casualties were again limited to the Sanriku coast.

5.4 The 869 Jogan Tsunami

While the above three tsunamis, unlike the 2011 tsunami, did not inundate the Sendai plain, a similar large earthquake and tsunami occurred there in AD 869, during the Jogan era on the Japanese calendar. A national history book, "Nihon Sandai Jitsuroku," depicts strong shaking, ground fissures, the collapse of houses, and casualties due to earthquakes. In addition, it describes the tsunami as having a sound like a thunder, which inundated along the river up to a castle. The flooded area is said to be hundreds of kilometers, with 1,000 people drowned. In addition, sand carried by this tsunami has been deposited as geological layers in the coastal lowlands, more than 4 km from the current coast on the Sendai plain (Minoura and Nakaya 1991; Sawai et al. 2012). Based on the distribution of tsunami deposits, the 869 Jogan earthquake has been modeled as an interplate $M = 8.4$ earthquake (Satake et al. 2008). Younger and older tsunami deposits have also been found, indicating a recurrence interval of 500–800 years if they are from the same type of earthquakes.

6 The 2011 Tsunami Source

The spatial and temporal slip distribution on the 2011 earthquake fault plane was estimated from 53 tsunami waveforms recorded at ocean bottom pressure gauges, GPS wave gauges, and coastal wave and tide gauges (Fig. 5; Satake et al. 2013). The results of this analysis show that the fault rupture started near the hypocenter, where a very large (>25 m) slip occurred on the deep plate interface within ~2.5 min. This was followed by even larger (up to 69 m) slip near the trench axis that propagated to the north. The final slip distribution (Fig. 5) shows that the fault slip increased toward the trench axis. The average slip over the 550 km long and 200 km wide fault was 9.5 m, and the total seismic moment is estimated to have been 4.2×10^{22} Nm (Mw = 9.0), comparable to other analyses of land-based observations. The slip distribution can be interpreted as a combination of shallow slip near the trench axis and deeper slip on the plate interface.

The slip near the trench axis is similar to that modeled for the 1896 Sanriku "tsunami earthquake" (Tanioka and Satake 1996). The huge shallow slip is responsible for the large sharp peak of the recorded tsunami waveforms (Fig. 3) and for the largest tsunami heights measured along the northern Sanriku coast, ~100 km north of the largest slip (Fig. 4). However, the shallow slip alone cannot reproduce the first stage of the tsunami, or the initial rise of water observed in the tsunami waveforms (Fig. 3). In addition, the seafloor deformation from the shallow slip has a short wavelength, and produces a tsunami with a period that is too short to inundate the Sendai plain for more than a few km (Fig. 6).

In comparison, the very large slip off Miyagi on the deep plate interface was similar to the previously proposed model of the 869 Jogan earthquake (Satake et al. 2008; Sawai et al. 2012), which reproduced the initial rise of observed tsunami

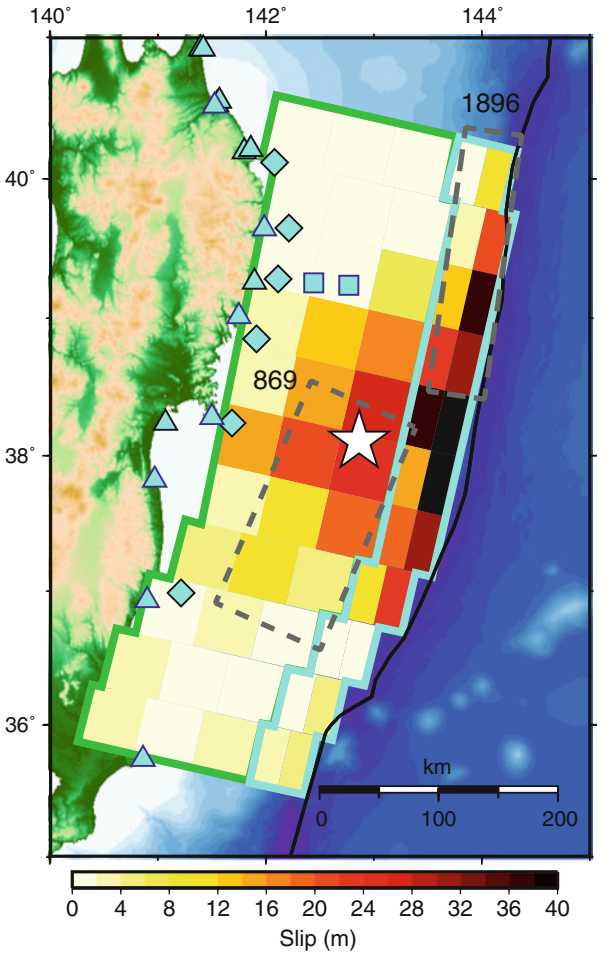

Fig. 5 The slip distribution of the 2011 Tohoku earthquake inferred from tsunami waveforms (Satake et al. 2013). The locations of bottom pressure gauges (*light blue squares*), GPS wave gauges (*diamonds*) and coastal wave and tide gauges (*triangles*) are also shown. Waveforms recorded at other stations outside the map are also used for the estimation of slip distribution. *Dashed rectangles* indicate fault models of the 1896 Sanriku tsunami earthquake (Tanioka and Satake 1996) and the 869 Jogan earthquake (Satake et al. 2008). The *blue* and *green frames* indicate the shallow and deep subfaults, respectively

waveforms as well as the large tsunami inundation in the Sendai plain. When the topography at the time of the 869 Jogan earthquake was used for the simulation, the computed inundation areas extend over the regions of known tsunami deposits, suggesting that the 869 tsunami source was similar to the deep slip of the 2011 source. However, the deep slip alone cannot reproduce the maximum peak of the tsunami waveforms (Fig. 3) and the largest tsunami heights on the Sanriku coast (Fig. 4).

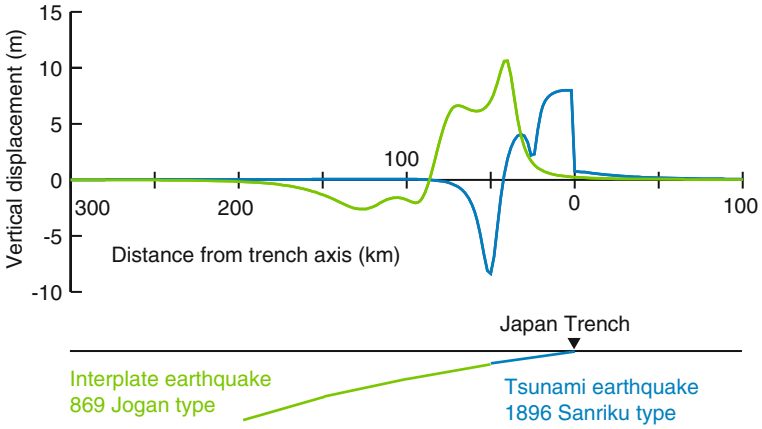

Fig. 6 Schematic cross section of the 2011 Tohoku earthquake fault (*bottom*) and vertical seafloor displacement (*top*) for the shallow (*blue*) and deep (*green*) subfaults

7 Conclusions

The 2011 Tohoku earthquake is probably the best-monitored subduction-zone earthquake ever. Land-based seismic and marine geodetic observation networks revealed the unique features of this earthquake, particularly the huge slip on the shallow plate interface. These observations have forced geophysicists worldwide to revise their views on the shallow part of subduction zones. In addition, the offshore observation of the tsunami demonstrated the use of such systems for the early detection of tsunamis. In the future, densely distributed bottom pressure gauges will be utilized for early tsunami warning systems.

The failure of long-term forecasts to foresee this earthquake and tsunami was due to simplified assumptions and limited data. Forecasts were based on the characteristic earthquake model and past earthquake data (for the last 400 years in this case). The long-term forecast should have incorporated data from the 869 Jogan earthquake, both its historical description and the extent of its tsunami deposit. In the future, forecasts should include such paleoseismological data, and they also need to consider variability in the recurrence patterns of great earthquakes (e.g., Satake and Atwater 2007).

The 2011 tsunami source was a combination of the shallow slip (1896 "tsunami earthquake") type and the deep slip (869 Jogan earthquake) type. Such simultaneous rupture, or triggering, of the shallow slip by deep slip, which amplifies or reduces coastal tsunami heights, was not considered in previous tsunami hazard assessments.

Gigantic earthquakes and tsunamis are rare phenomena. Only a few $M \sim 9$ earthquakes occurred in the world over the last century. For such infrequent hazards, education is also important and effective in reducing the scale of disasters. Experiences gained from past tsunamis needs to be communicated to the next generations who can use such knowledge to reduce the impact of future tsunami disasters.

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East Japan Mega Earthquake and Dual Reconstruction Scheme-Regional and National Planning of Post-Disaster and Pre-Disaster Recovery

Itsuki Nakabayashi

Abstract Reconstruction from the Eastern Japan mega earthquake must be done as a post-disaster recovery from the affected region of eastern Japan as rapidly as possible. However, these reconstructions are not done quickly. On the other hand, the damage prevention and preparedness as a pre-disaster recoveries and reconstructions from the next Nankai trough earthquake has to be progressed steadily, because the probability of the earthquake is not low in the next three decades. The Japan has to implement the dual reconstruction scheme of post-disaster recovery in East Japan and pre-disaster recovery in West Japan, The post-disaster recovery must be done in the next 5 years, as quickly as possible. The pre-disaster recovery must be prepared simultaneously, and begin to reconstruct the Tokyo Metropolitan region and also the Pacific Ocean Cost region included with Nagoya Metropolis and Osaka Metropolis on and on. This Dual Recovery Strategy can reduce the damage of next mega-disaster and can make the resilience of both the Nation and Metropolises stronger. The Eastern Japan, the Tokyo Capital region and the Western Japan can be supported each other against the next mega-disasters.

Keywords East Japan mega earthquake • Tsunami • Recovery • Reconstruction • Pre-disaster recovery

I. Nakabayashi (✉)
Graduate School of Political Science and Economics, Research Center for Crisis and Contingency Management, Meiji University,
1-1 Kanda-surugadai, Chiyoda-ku, Tokyo 101-8301, Japan
e-mail: nakaba47@meiji.ac.jp

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1 Characteristics of the East Japan Mega Disaster and 2-Year Recovery Process

1.1 Japan Has Historically Recovered from Many Great Disasters

Japan is located in one of the most seismically active regions in the world, where the Pacific, North American, Philippine Sea and Eurasian plates join. The country has experienced several great earthquakes every century. In the Twentieth century, there were five great earthquakes that each killed more than a thousand people, and from which the nation recovered: the Great Kanto earthquake of 1923, the Mikawa earthquake of 1945, the Nankai earthquake of 1946, the Fukui earthquake of 1948, and the Hanshin-Awaji earthquake of 1995. In that century, Japan underwent modernization of society, population growth and strong economic growth, in spite of several severe disasters and World War II. In the latter half of the 1900s, many earthquake disasters occurred, although none as devastating as the Great Kanto earthquake. Strong national economic growth was achieved in 1960s, 1970s and 1980s, during which time there were no great disasters. The Great Hanshin-Awaji Earthquake was tremendous urban disaster and subsequent recovery for the first time in post-war Japan. After this disaster, there are many earthquakes in the twenty-first century of Japan. The nation learned historically many things from these experiences.

In 2011, the powerful earthquake of Richter magnitude 9.0 and terrible tsunami disaster struck. How can the Japanese people recover from this enormous disaster in a society with depopulation and aging, while undergoing a severe economic depression? Table 1 suggests that our predecessors recovered and reconstructed the country and society from more severe earthquake and tsunami disasters.

In East Japan, the Meiji Sanriku tsunami of 1896 killed 22,000 people, and the East Japan earthquake tsunami of 2011 was on a similar scale, killing and missing about 20,000. However, from the view-point of figures such as ratio of deaths per 10,000 people, the impact of the 1896 disaster was more than three times greater than its 2011 counterpart. Historically not only East Japan but also West Japan has recovered many times from such huge disasters of tsunami, earthquake, typhoon and so on. It will also be able to recover not quickly but steadily from the latest one, which is comparatively not greater than historical disasters (see Table 1).

1.2 Characteristics of the East Japan Earthquake and Tsunami Disaster of 2011

At 14:46 on 11 March 2011, the Richter magnitude 9.0 East Japan mega earthquake caused a great tsunami disaster along 2,000 km of the eastern coastal region of Japan. Six prefectures were affected, mainly by the tsunami rather than the earthquake. The tsunami affected more than 200,000 buildings in built-up districts of an

Table 1 Historical great disasters and the East Japan earthquake

Name of earthquake and tsunami disasters, which caused duplicated disasters	Year	National population (thousands) (a)	Killed and missing (b)	Ratio of killed (b/a)×100	Other incidents
Jogan-Sanriku tsunami	869	7,000	1,000	1.43	864:Mt. Fuji eruption
Nankai earthquake with tsunami	887	7,000	Many	–	
Tokai earthquake with tsunami	1096	8,000	Many	–	
Nankai earthquake and tsunami	1099	8,000	Many	–	
Keicho Toukai-Tonankai earthquake with tsunami	1605	12,000	2,500	2.08	
Keicho Sanriku tsunami	1611	12,000	6,800	5.67	
Genroku earthquake and tsunami Hoei Tokai-Tonakai	1703	20,000	5,200	2.60	1707:Mt. Fuji eruption
earthquakeand tsunami	1707	20,000	4,900	2.45	
Tenmei Yaeyama earthquake and tsunami	1771	23,000	15,000	6.52	
Mt. Unzen eruption and tidal wave	1792	24,000	15,000	6.25	
Ansei Tokai and Nankai earthquakeswith tsunami	1854	30,000	20,000	6.06	
Ansei Edo earthquake	1855	30,000	10,000	3.33	1858–59: Half a million die
Nobi earthquake	1891	40,000	7,200	1.80	of cholera
Meiji Sanriku tsunami	1896	42,000	22,000	5.24	
Great Kanto earthquake	1923	60,000	100,000	16.66	
Syowa Sanriku tsunami	1933	70,000	3,100	0.44	
Tonankai earthquake with tsunami	1944	76,000	1,300	0.17	
Mikawa earthquake	1945	76,000	2,300	0.30	
Aerial bombing of World War II[1]	1945	76,000	331,000	43.55	2.3 million houses in 115
Makurazaki Typhoon	1945	76,000	3,800	0.50	cities burned[2]
Chasrine Typhoon	1946	76,000	2,000	0.26	
Fukui earthquake	1948	76,000	3,800	0.50	
Isewan Typhoon	1959	93,000	5,100	0.54	
Hanshin-Awaji earthquake	1995	124,000	5,500	0.44	110,000 buildings collapsed
East Japan mega earthquake with tsunami	2011	126,000	20,900	1.66	130,000 buildings collapsed

[1]National Astronomical Observatory of Japan (ed. 2012) Chronological scientific tables 2012., Maruzen, Tokyo, Japan
[2]Ministry of Construction (ed. 1957) Report of reconstruction after World War in Japan (Sensai-fukkou-shi), Vol.1, Tokyo, Japan

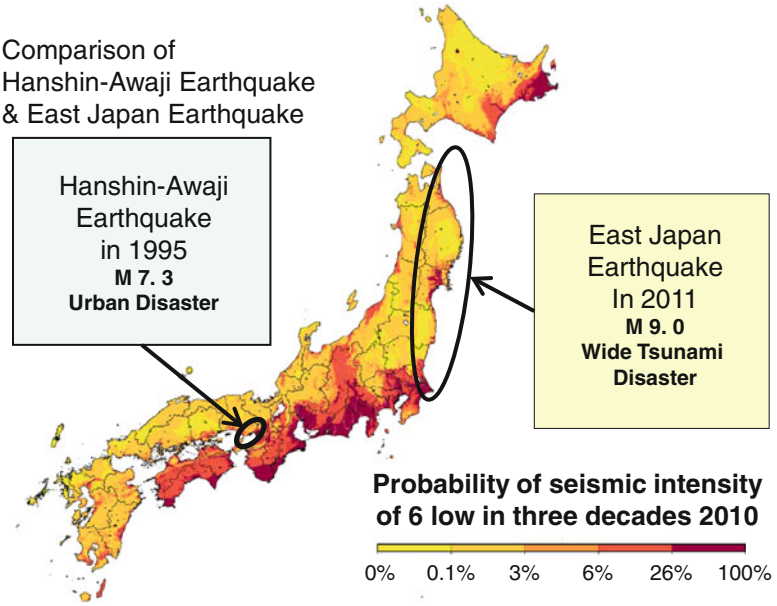

Fig. 1 Comparison of Hanshin-Awaji and East Japan earthquakes

area of approximately 535 km^2. Substantial farmlands and facilities were flooded. The severely damaged area was approximately 100 km^2. Approximately 130,000 houses collapsed and were washed away by floodwater of tsunami. More than 170,000 partially collapsed in tsunami flooding districts. In addition to the 20,900 people killed or missing, only 6,000 injured. In disaster of earthquake, not tsunami, number of injured is ten times more or less than killed.

In the 1995 Great Hanshin-Awaji earthquake that caused damages mainly by ground shaking, 112,000 houses severely collapsed, 5,500 were killed, and more than 43,000 were injured by house collapse. In a tsunami disaster, lives can only be saved by evacuating to high ground. If people cannot evacuate quickly and are impacted by the tsunami, they tend to be killed rather than injured (Figs. 1 and 2).

In the 2011 event, several cities and towns were severely destroyed, more than 70 % of the population was affected by the tsunami, and more than 50 % lost their houses and household effects. In the most severely damaged towns, greater than 80 % were affected by the tsunami in the towns of Otsuchi, Minami-sanriku, Onagawa and the city of Higashi-matsushima. Seventy-four of houses collapsed and were washed away in Onagawa town, and 60 % of houses also in Minami-sanriku town. In many cities, burning ships were washed into urban districts and many large fires spread in districts flooded by the tsunami. More than 50 km^2 of land subsided, approximately 10 km^2 below high-tide sea level (Table 1 and Fig. 3).

The principal of reconstruction of fishery villages after the 1933 event was presented as follows; (1) relocation of fishery village onto high land is best measure

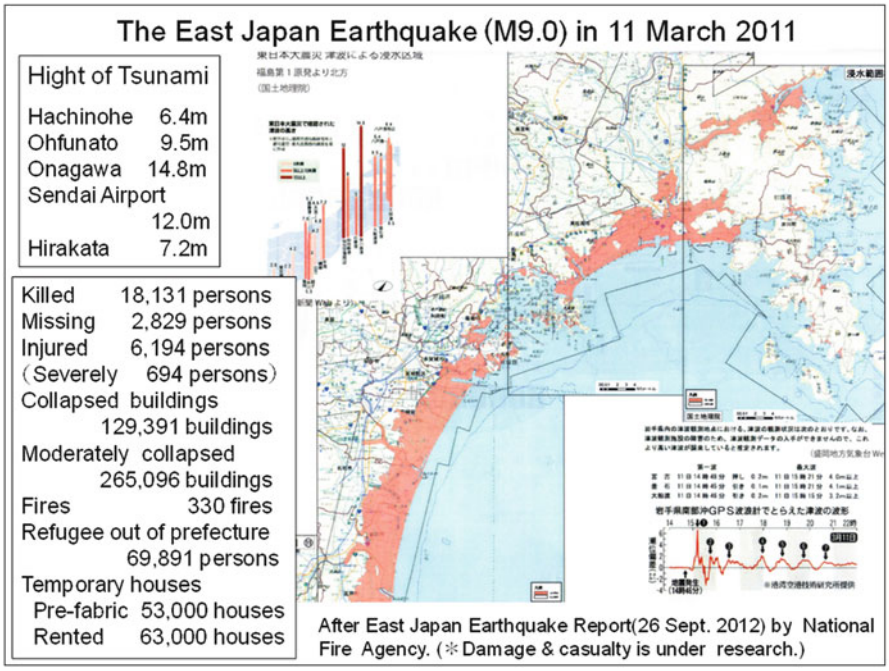

Fig. 2 Damage from East Japan earthquake tsunami disaster

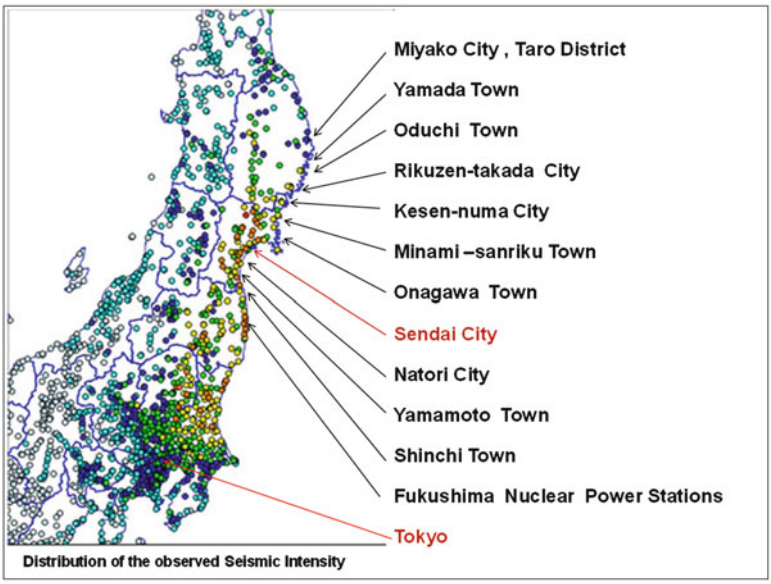

Fig. 3 Principal cities affected and seismic intensity of East Japan mega earthquake

against tsunami, (2) site of relocation has to be selected according to five standard, accessibility of seaside, land higher than previous tsunami, viewing of seaside, southern slope of sites and easefulness to get drinking water. The relocation of fishery villages onto high lands was a key-propose of reconstruction plan of fishery villages in Sanriku region of saw-toothed coastline after Syowa Sanriku tsunami disaster. Not a few of villages relocated on to highlands and also continued to construct seawalls and gates.

In the post-war period, not only economics but also population was growing rapidly in whole of Japan. The sites of highland come short and houses were built on the site of lowland guarded by seawalls and gate. However, the village of Fudai was protected by seawalls and head gates constructed after the Syowa Sanriku tsunami of 1933. In the Fudai village reconstruction period after that event, the chief of the village requested that they be built higher than the height specified in the Miyagi Prefecture reconstruction plan As a result, damage and victims of Fudai village is very few and slight. However, in almost of all lowlands, the great tsunami higher than seawalls and gate was rushing over them. Many of houses and buildings were collapsed and many people died (Table 2).

1.3 Recovery Process in the 2 Years Following the East Japan Mega Earthquake

Several days after the earthquake, a maximum of about a half million people were evacuated into shelters, such as public schools and public facilities. There were shortages of food, water, clothes, gasoline, other goods and social services for survivors, all of which were lost in the areas most severely affected by the tsunami. People lived in very difficult conditions in shelters and damaged houses for several months. Five months later, in August, more than 87,000 people in tsunami-affected prefectures were still living in various shelters. In these severely impacted areas, many types of jobs were lost, including fishing and fishery processing, shops, restaurants, and other service industries. In addition, all urban central functions ceased, because city and town halls were completely destroyed. As a result, more than half local residents not only lost their families and relatives, they also lost their jobs.

In addition, approximately 330,000 living within a 30-km radius of nuclear power stations in Fukushima Prefecture left their home towns. Additionally, 70,000 left Fukushima for other prefectures because of radiation contamination from the Fukushima nuclear power plant, which was struck by the tsunami. This evacuation continued over the next 2 years. Many lost jobs and separated from families. Mothers and children left Fukushima, while a parents and fathers remained.

Many people wanted to move from shelters to temporary housing as soon as possible. Until August 2011, approximately 40,000 temporary housing units were supplied. Nevertheless, more than 10,000 units sat empty because their locations and living conditions were poor. Temporary housing was provided outside of previous residential areas that had been affected by the tsunami. People had lost their

Table 2 Damage and damage ratios in main local government jurisdictions

Local government jurisdiction	Population (persons) (a)	Families (b)	Families in tsunami area (%)	Killed and missing (c)	Killed and missing (per million) (c/a)	Collapsed houses (buildings) (d)	Collapsed ratio (%) (d/b)
Noda village	4,632	1,576	67.8	38	8.2	311	19.7
Fudai village	3,088	1,042	36.5	1	0.3	0	0
Tanohata village	3,843	1,309	40.2	29	7.5	225	17.2
Miyako city	59,442	22,504	32.0	527	8.9	3,669	16.3
Yamada town	18,625	6,605	63.2	757	40.6	2,762	41.8
Otsuchi town	15,277	5,674	81.3	1,282	83.9	3,092	54.5
Kamaishi city	39,578	16,095	32.5	1,046	26.4	2,955	18.4
Ofunato city	40,734	14,814	47.0	424	10.4	3,629	24.5
Rikuzentakada city	23,302	7,794	71.7	1,795	77.0	3,341	42.9
Kesennuma city	73,494	25,464	54.9	1,356	18.5	8,483	33.3
Minami-sanriku town	17,431	5,295	82.6	845	48.5	3,142	59.3
Onagawa town	10,051	3,968	79.5	815	81.8	2,923	73.7
Ishinomaki city	160,704	57,816	72.9	3,735	23.2	22,357	38.7
Higashi-matsushima city	42,908	13,995	80.4	1,105	25.7	5,470	39.1
Shiogama city	56,490	20,314	34.3	32	0.6	757	3.7
Shitigahama town	20,419	6,415	42.9	76	3.7	673	10.5
Watari town	34,846	10,819	38.5	269	7.7	2,298	21.2
Yamamoto town	16,711	5,233	55.7	690	41.3	2,333	44.6
Shinchi town	8,218	2,461	56.9	115	1.4	439	17.8
Soma city	37,796	13,240	23.2	458	12.1	1,782	13.5
Minami-soma city	70,895	23,643	15.7	638	9.0	5,432	23.0
Namie town	20,908	7,171	14.0	184	8.8	613	8.5
Naraha town	7,701	2,576	21.1	37	4.8	50	1.9
Hirono town	5,418	1,810	24.5	3	0.6	?	?
Iwaki city	342,198	128,516	8.8	310	0.9	7,710	6.0

vehicles, and the temporary homes were located far from previous areas. Temporary housing areas lacked shops, schools, medical services, transportation and other social services. Many people remained in shelters, where they could obtain food and other goods from public assistance. However, shelters were closed in the end of August 2011. People tended to live alone in temporary housing and had few home-related costs. Until summer 2012, temporary shops were built in the affected central areas and in open spaces near temporary housing sites.

In autumn 2011, there were people living in 53,000 temporary prefabricated houses set up by the prefectural government according to requests of local

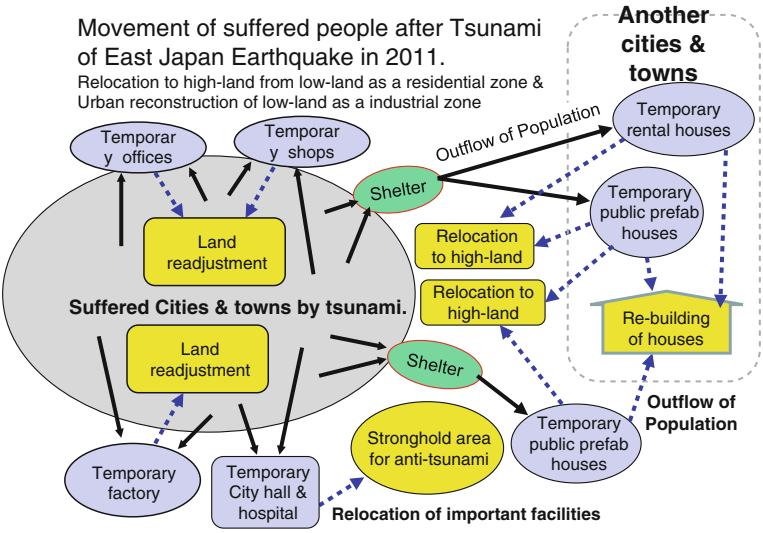

Fig. 4 Process of recovery in area affected by tsunami over 2-year period

governments. It was difficult to provide temporary housing because of shortage of sites for temporary housing and materials of prefabricated houses. Therefore, people were living in 63,000 private houses rented by the prefectural government. However, there were few rental houses in affected areas, where there were small towns and villages and where the majority of such houses had been lost to the tsunami. Therefore, houses were rented in metropolitan and urban areas such as Sendai, Fukushima, Ichinoseki, Kitakami, and other areas that had suffered less impact.

In coastal areas affected by the tsunami, there were few jobs. Therefore, many young families preferred to rent homes in urban areas where they could find new jobs. The job loss in affected areas caused many people, especially the young, to move from their coastal hometowns to inland urban areas. As a result, the population in the affected areas is aging declining rapidly (Fig. 4).

There are 41 local governments in the coastal zone of the principally affected prefectures (Iwate, Miyagi and Fukushima). According to citizen registration data, population trends in these 41 local government jurisdictions are shown in Table 3. In 40 of these jurisdictions, the population decreased during the 23 months following the 2011 tsunami disaster. Only in the metropolis of Sendai, where there are many rental houses for temporary residency, was the population increasing. The population of two jurisdictions, Otsuchi and Onagawa towns, that were the most severely damaged, decreased by less than 20 %. The population of six jurisdictions in Iwate and Miyagi prefectures fell by less than 10 % in the 2 years following the event. The decline in population was represented not only by the victims of the tsunami, but also by migration from affected areas to metropolitan and urban areas to seek jobs and temporary rental housing (Table 4).

Table 3 Population trends after the East Japan mega earthquake disaster

Prefecture		Iwate	Miyagi	Fukushima	Total
Local government jurisdictions in coastal zone affected by tsunami		12	15	14	41
Population decrease	Less than −20 %	1	1	0	2
	−20 to −15 %	1	2	0	3
	−15 to −10 %	1	0	0	1
	−10 to −5 %	2	3	8	13
	−5 to −0 %	7	7	6	20
Population increase		0	1	0	1

From citizen registration data during 23 months from 1 March 2011 to 1 February 2013

Table 4 Damage and casualties of East Japan mega earthquake disaster

Prefecture		National total	Iwate	Miyagi	Fukushima
Killed		15,881	4,673	9,535	1,606
Missing		2,676	1,151	1,310	211
Relative killed		2,688	389	862	1,383
Collapsed houses		129,391	19,199	85,311	20,047
Refugee, not in prefecture		69,891	1,593	8,251	60,049
Temporary houses	Units	118,784	16,829	42,940	40,937
	Population	292,846	39,976	107,552	97,117

[a]Casualty data, from the National police agency, March 2013
[b]Data of relative killed, from the National agency of recovery and reconstruction, January 2013
[c]Data of collapsed homes and refugee data, from National fire agency
[d]Data of temporary houses, from Japanese Ministry of Land, Infrastructure, Transport and Tourism

2 Post-Disaster Recovery from the 2011 East Japan Mega Earthquake

2.1 Lessons from Recovery and Reconstruction After the Hanshin-Awaji Earthquake

In the years of 1944–1948, in and after World War II, Japan had to recover from ruinous situation. In addition to total destruction from war, many earthquakes and typhoons that each killed more than a 1,000 people struck the weakened country (Table 1). However, the nation recovered quickly, and strong economic growth levels were reached in the 1960s.

In the postwar period of the twentieth century, the Isewan typhoon (1959) and Hanshin-Awaji earthquake (1995) are disasters worthy of special mention since these altered Japanese disaster countermeasures. The typhoon, which killed and missing 4,000 in Aichi Prefecture and more than 1,000 in Mie Prefecture, led to establishment of the Basic Law of Japanese disaster management. Since then, the national government, various related organizations and local governments have

established the Disaster Management Plan each other. Strong national economic growth occurred not only in the disaster-free period of the 1960s, 1970s and 1980s, but also during periods of preparedness by national and local governments.

The Hanshin-Awaji earthquake presented post-disaster recovery concern during a transition period in Japanese society and the economy, from vigorous economic growth to aging society. In 1995, the aforementioned magnitude 7.3 earthquake struck southern Hyogo Prefecture, with the epicenter 20 km below Kobe. More than 5,500 were killed, over 105,000 buildings collapsed and more than 7,000 burned down. More than 200,000 houses were lost, and 46,000 temporary housing units were constructed. Nevertheless, many of the people affected lost their home, but did not lose their jobs or their workplaces. Many people were able to recover their livelihood and homes onsite, in contrast with recovery and reconstruction of the East Japan disaster.

However, by the end of the twentieth century, population growth slowed and the society was aging rapidly. Nevertheless, approximately 300 ha in urban districts that had burned down or in adjacent areas where there had been crowded wooden houses were reconstructed, via land readjustment or urban redevelopment projects. Within 5 years of the earthquake, the number of houses constructed in and around the affected areas was as same as collapsed. T population decrease in affected areas fully recovered in and around Kobe metropolitan region. However, the population did not recover in the affected inner city area of Kobe such as Nagata Ward area. During the 5 years of recovery, there were no earthquake disasters in Japan. The experience of recovery and reconstruction from this event (i.e., a typical urban earthquake disaster, not wide area earthquake disaster like East Japan mega earthquake) has taught us many things. The main lessons learned from the Hanshin-Awaji earthquake regarding post-disaster recovery and reconstruction common to the East Japan mega earthquake as follows.

1. Community-based aid and activities are very important. In severely damaged districts, community-based conventions were established for making community redevelopment plans. More than 50 meetings were held in each convention on average, and many things discussed. The continuity of relationships in each community is very important. In shelters and temporary housing, these community relationships must be maintained, especially in an aging society.
2. Process management of recovery and reconstruction policies is essential. Five to ten years are necessary to recover and rebuild damaged community district facilities and houses. However, sufferer must have some income to carry on with their lives. During recovery and reconstruction of residential and central districts in each city, it is critical to maximize various temporary jobs in affected areas. These temporary jobs boost the motivation of disaster victims toward recovery. Unless these people can find employment, community recovery and reconstruction and rebuilding of their homes are incomplete. Tokyo metropolitan government has proposes a “temporary town project”, learning from the Hanshin-Awaji earthquake. A temporary town project is necessary to recover livelihoods and rebuild residential districts, which consist of temporary houses, shops, factories, offices, and various facilities similar to the previous town.

Fig. 5 Relocation of houses after 1933 Syowa Sanriku tsunami in city of Ofunato, Iwate Prefecture

3. A fund for community-based recovery and reconstruction activities is very important to implement aid for disaster victim self-recovery and to stimulate independent activities in communities and of individuals. Such a fund can assist individually and intimately the activities of community organizations for district reconstruction and of neighborhoods.

2.2 Recovery and Reconstruction from the East Japan Tsunami

In the Sanriku coastal region of Iwate and Miyagi prefectures, various tsunami countermeasures were traditionally implemented. As mentioned before, in a reconstruction plan of damaged fishery villages from the Syowa Sanriku tsunami of 1933, relocation of houses from lowlands to highlands was the most important principle of the reconstruction project conducted by the national government. Numerous villages were rebuilt through such relocation (Fig. 5). Almost all of these relocated districts avoided damage from the East Japan tsunami.

However, the population increased in a strong economic growth periods, and there was a shortage of housing sites in the highlands. Therefore, people began to build houses in lowlands guarded by seawalls (banks) and gate. Recently, every prefecture prepared and distributed tsunami hazard maps to all homes. Figure 6 is such a map of the Taro district in Miyako jurisdiction. In that district, a 10-meter-high tsunami banks were constructed over a long period after the 1933 tsunami disaster. When the huge

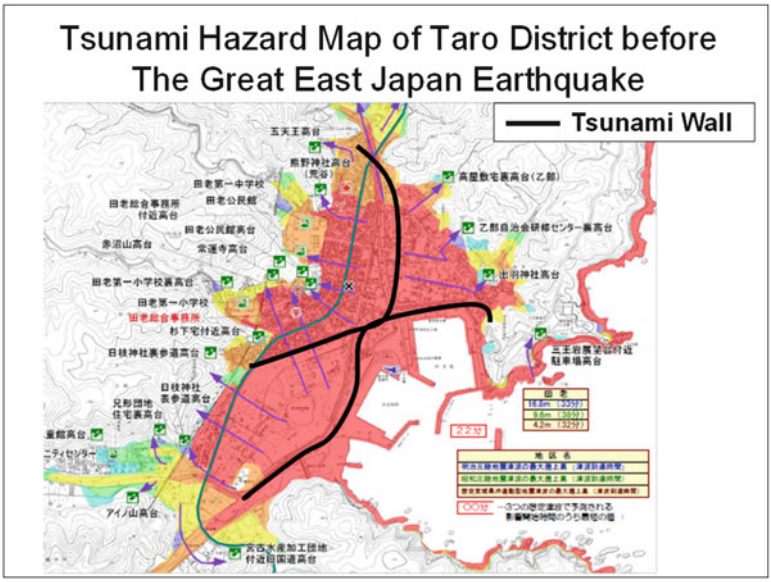

Fig. 6 Tsunami hazard map of Taro district, distributed by Miyako city

tsunami caused by the 1960 magnitude 9.5 an (Valdivia) earthquake arrived in the areas around Sanriku more than 28 h after the earthquake, these banks fully protected Taro district. However, these bank were flooded over and destroyed in the East Japan mega earthquake event (Fig. 7). Although many people evacuated to highland districts after a big ground motion of earthquake, many who believed in the effectiveness of these banks and delayed evacuation were killed by the tsunami.

In case of the East Japan mega earthquake disaster, the recovery process of both moderately and severely affected areas as well as of society has been slower than that of the Hanshin-Awaji earthquake. In April 2011, 1 month after the disaster, a principle and vision of recovery and reconstruction had begun to be formulated. Draft plans were made by each town and city in June and July, through discussions in planning advisory committees. All cities and towns established citizen participation systems for recovery and reconstruction plans. In September, these plans were being finalized by local governments, in spite of a shortage of citizen participation.

2.3 Planning Aid for Reconstruction of Affected Areas by the Ministry of Land, Infrastructure, Transport and Tourism

How can the lives and jobs of people affected by the tsunami disaster in Japan be recovered? How can we rebuild more livable housing? How can impacted urban areas and fish villages be reconstructed? How can we recover agricultural lands, farms and industries? Neither local nor national governments effectively and

Fig. 7 Tsunami banks in Taro district destroyed by 2011 EJ tsunami

Table 5 Decision periods of recovery and reconstruction plans of 43 governments

	2011			2012
Plan items	April–June	July–September	October–December	January–March
Keynote and vision	14	6	2	0
Outline	1	2	(2)	(2)
Reconstruction	1	11	23	5
Comprehensive	0	0	1	0
No planning yet	–	–	–	3

After Ministry of Land, Infrastructure, Transport and Tourism (2012)

systematically advanced recovery and reconstruction of affected districts and societies. In June 2011, these endeavors were begun in earnest by these governments. The basic law of reconstruction of the East Japan mega earthquake was established on 24 June 2011. For recovery and reconstruction were determined by the national government on 29 July. The special zone act of principal policies for earthquake recovery and reconstruction was established on 7 December. The reconstruction agency was established on 10 February 2012.

To support 43 local governments in severely affected areas and develop the recovery and reconstruction plan, the Ministry of Land, Infrastructure, Transport and Tourism conducted basic damage assessment and technical surveys. Plans were decided by 40 of the 43 local governments (Table 5). The ministry supported 32 governments planning relocation of houses to higher ground and reclaimed land readjustment in flooded districts. These projects involve 208 districts, including 76 urban districts, 7 semi-urban districts, and 125 villages.

Table 6 Decision method of reconstruction pattern

Method of deciding plan pattern in each district	Adopted pattern of district reconstruction				
	(A) Relocation of houses to high ground or inland	(B) Integration of houses and land reclamation	(C) Relocation of houses and land reclamation	(D) Integration of houses	Total
Compared with other patterns	45	13	12	18	88
Adaptation without alternatives	82	12	6	20	120
Total	127	25	18	38	208

After Ministry of Land, Infrastructure, Transport and Tourism (2012)

Table 7 Decision factors in reconstruction pattern

Decision factor	Adopted pattern of district reconstruction				
	(A) Relocation of houses to high ground or inland	(B) Integration of houses and land reclamation	(C) Relocation of houses and land reclamation	(D) Integration of houses	Total
Local consensus	26	7	10	10	53
Safety check with tsunami simulation	28	3	4	5	40
Cost and period of project works	8	4	1	6	19
Balance of land use in city area	0	2	3	1	6
Houses rebuilt in district	3	0	1	2	6
Total	65	16	19	24	124

After Ministry of Land, Infrastructure,Transport and Tourism (2012)

The proportions of reconstruction proposals of 208 districts are shown in Table 6. In 88 districts, the reconstruction plan was decided in comparison with another pattern as an alternative plan. In 120 districts, the adopted plan was decided without such an alternative. The plan was by local consensus in 53 districts (Table 7). The safest reconstruction pattern was selected via computer simulation of a tsunami in 40 districts. As a result, house relocation patterns to high ground or inland, where a worst-case tsunami could not impact, was adopted in 65 of 124 districts.

2.4 Process of Recovery and Reconstruction Planning in Case of Minami-Sanrikut

The town of Minami-sanriku s one of the most severely damaged jurisdiction by the tsunami. More than 80 % of all families living in coastal residential areas in the mountains were affected, and more than 60 % of houses collapsed (Fig. 8).

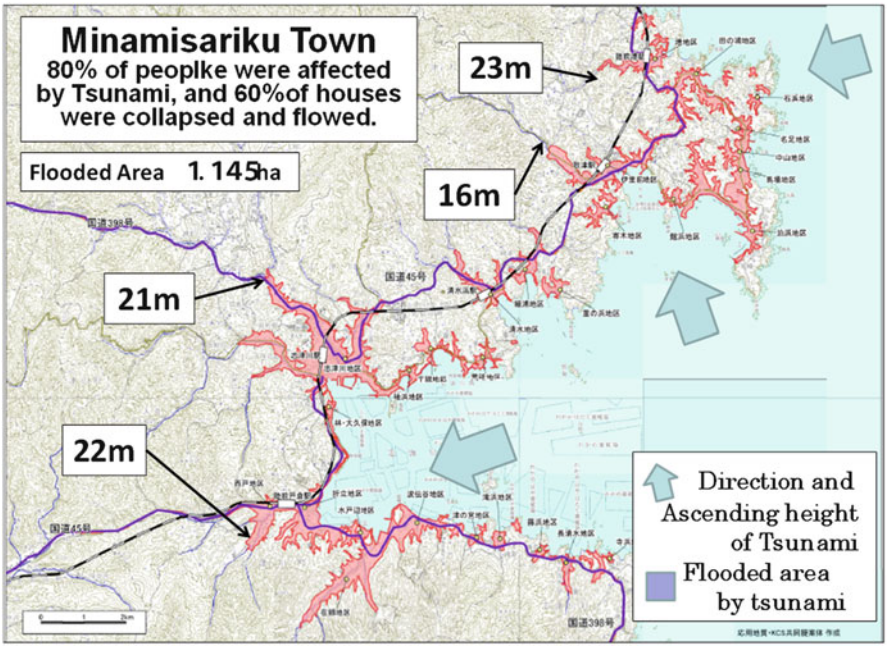

Fig. 8 Heights reached by tsunami flooding in town of Minamisanriku

Figures 9 and 10 are images of reconstruction in affected areas, through relocation of houses to highlands and land readjustment of reclaimed lowlands in small towns. Lowlands must be recovered using multiple defensive facilities, such as tsunami banks, locked gates, main roads, tsunami evacuation buildings, and railway. I suggested these concepts to several affected cities and towns in April and May of 2011. In June, the Committee of Recovery and Reconstruction Planning was established in Minami-sanriku. I committed to formulating a plan as a member of that committee and as a planning research advisor to the Ministry of Land, Infrastructure, Transport and Tourism.

The reconstruction concept of Minami-sanriku is for new town construction, because more than 60 % of houses and major public facilities (including the town hall, hospital and others) were flooded by the tsunami. It is important to do planning with citizen consensus through a careful participation. What town must be reconstructed for residents and business owners? However, it was very difficult to do close participations after disaster. Therefore, the philosophy and vision for recovery and reconstruction of Minami-sanriku was based on the Vision and Comprehensive Plan that was published 3 years before the disaster through close citizen participation.

The most important issues are the relocation of houses from lowlands to highlands and redevelopment of the central district as a center of commerce, business and industrial zones. However, it was very difficult to decide on a land use plan for town reconstruction, because financial support from the national government was

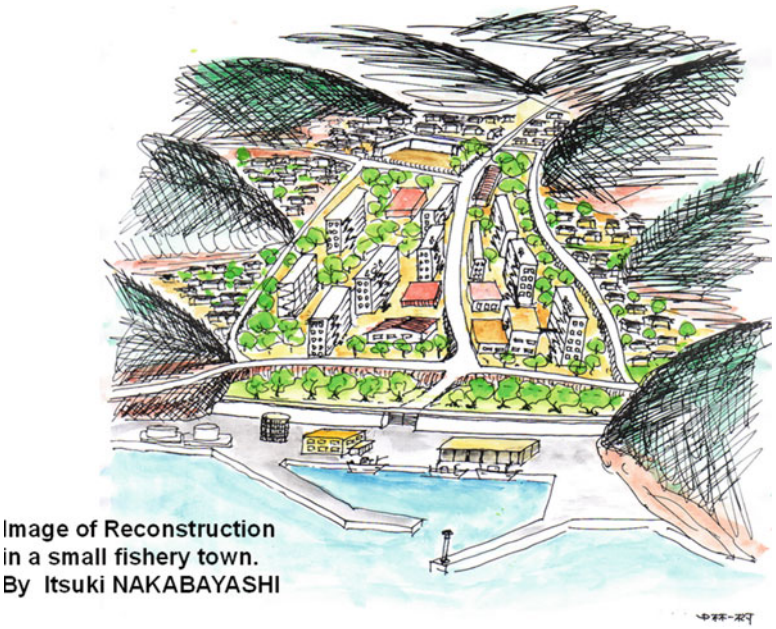

Fig. 9 Reconstruction design of small town (suggested by I. Nakabayashi)

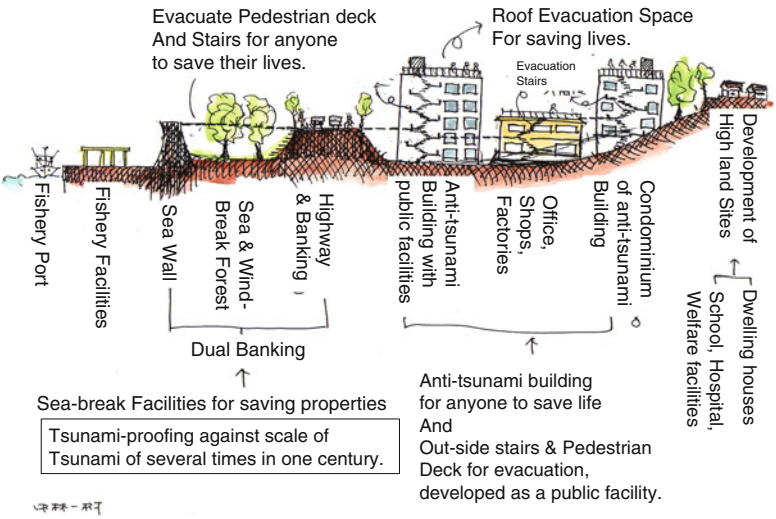

Fig. 10 Reconstruction concepts for small town (suggested by I. Nakabayashi)

not publicized until November 2011. Inter-prefectural infrastructures, such as national highways, railways, tsunami banks (seawalls), gates, seaports and others, had not been decided yet. There was no information on infrastructures that are foundational for lowland land use. How were highway and railway routes to change?

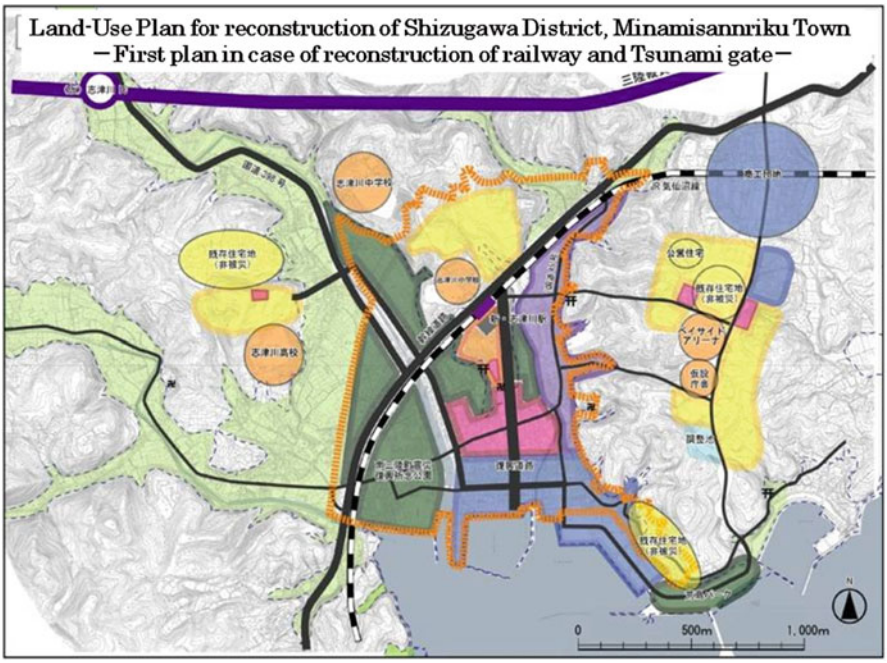

Fig. 11 First draft plan of land use for reconstruction of Shizugawa, with railway and lock gate

How were highways to be constructed? How were tsunami banks and lock gates to be repaired?

Figure 11 shows the first draft plan for reconstruction of Shizugawa, the central district of Minami-sanriku. In this plan, the railway would be built with a new station in a new highland central zone. This new central district would be protected by tsunami banks, lock gates and a national road and railway, both with banks. Three groups of residential sites would be developed in the highlands.

In October 2011, Miyagi Prefecture decided that lock gates for tsunami defense would not be constructed, because of maintenance and renewal costs. Tsunami banks would be constructed along both the seafront and riverside. The East Japan Railway Company stated that the railway would be very difficult to be reconstructed at present. Bus service would be the alternative to the railway. The central area would be protected only by tsunami banks (Fig. 12). The second draft plan of reconstruction of the Shizugawa district was approved in March 2012.

In June 2012, the Shizugawa community organization of reconstruction projects was established, and discussion for decision making among citizens and businesses initiated. This discussion has continued. Owners of some businesses such as shops and small hotels wanted to move to the highlands for safety reasons and to locate their establishments near residential zones.

More than 2 years will be needed for completion of development. However, decisions between citizens, businesses and government regarding the development project have not been fully made. The road to reconstruction of the town is very long.

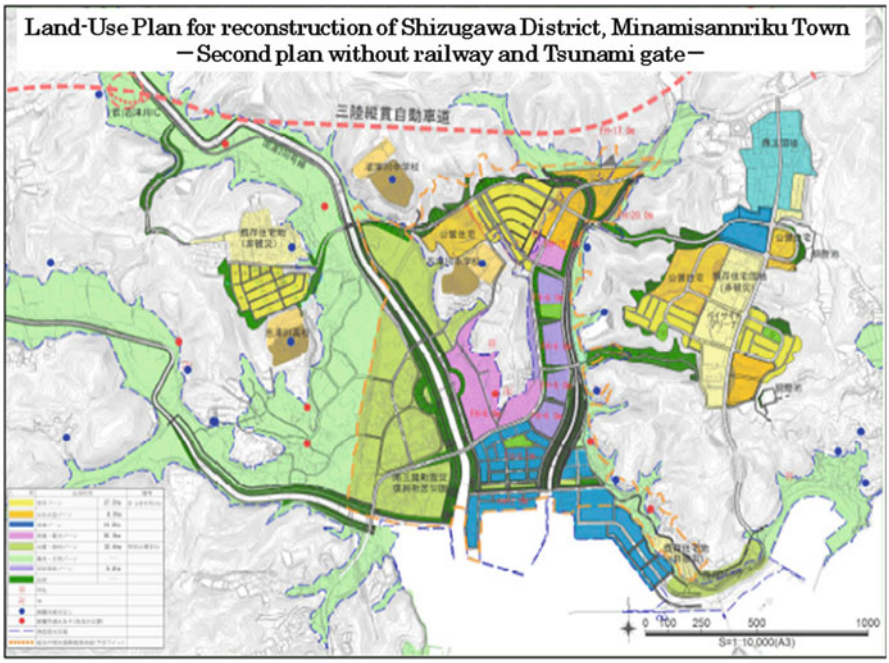

Fig. 12 Second plan of land use for reconstruction of Shizugawa, without railway and lock gate

2.5 How to Resolve Delays in Job Recovery and Industry Reconstruction

Disaster-affected fishermen, tradesmen, workmen, and others cannot wait long to restart their working lives. They want to o so, and envisage recovery of their livelihoods and rebuilding of permanent houses as rapidly as possible. Disaster victims who are jobless and who feel hopeless represent the most important problem in community recovery and reconstruction.

To rebuild tsunami-safe houses that can prevent future loss of life, many people want to move from seaside lowlands to hillside highlands. However, there are differing opinions within the community. Some want to rebuild houses in the seaside lowlands because of their jobs (for example, fishermen). Some want to rebuild shops in the central lowlands of the town.

All these wishes aside, there are restraints from geologic characteristics. In the plain area, for example a southern region from Sendai city, there are no highlands near the original village and the urban district that can be developed. It is not easy to acquire land for community relocation because of farmland and other land use. In the saw-toothed coastline area, mainly a northern region from Sendai city, there is a shortage of land for developing new sites, because of narrow valleys and steep mountains. Almost all narrow valleys were flooded by the tsunami. Even if a large

mountainside area was developed for community relocation, there would be concern regarding effects on the ecological system of coastal regions. The sea off East Japan, which is the most valuable fishing area, is sustained by the natural environment of the mountainsides.

Where can people find suitable jobs, and where can they work? Where can they rebuild their homes? It is necessary to repeatedly address the issue of location of residences within the entire community. Nevertheless, people from the same community have lived separately in temporary housing. Young families who affected by the disaster and are the breadwinners of the future community, departed affected areas for urban areas to find suitable jobs and they can be finding jobs in various sectors. The job market is unsuitable for victims in the affected areas, although construction-sector jobs are increasing.

Every affected local government made a recovery and reconstruction land use plan in the 6 months following the great tsunami. Each plan was to be decided upon by 11 November, which was the time limit of building regulation for planned reconstruction in affected districts. It is important to implement every recovery and reconstruction project in a flexible manner. The plan must be altered because of change in social activities, economic conditions, the intent of people toward rebuilding homes, jobs, and other factors. To evaluate the plan, recovery and reconstruction assessment is an important process management method. In the next decade, recovery process management will be important, as will implementing the recovery and reconstruction vision. It is the greatest requirement to enable victims to obtain permanent or temporary jobs. Jobs and income will enhance their motivation to revive and rebuild after the disaster.

3 Forecasting of Earthquake Disasters in Twenty-First Century Japan and National Strategy of Dual Recovery

3.1 How to Increase the Population in the East Japan Affected Area

In affected areas of east Japan, there are few jobs, houses, or social services (including medical and commercial). Poor living conditions have caused people, especially young families with children, to leave their hometowns for metropolitan areas with jobs. Temporary rental houses have accelerated this emigration.

According to monthly population data of each government, there has been a population decrease over the last 2 years following tsunami of approximately 72,000 within 40 local government jurisdictions in three affected prefectures – Iwate, Miyagi and Fukushima. In contrast, population in the metropolis of Sendai has increased by about 28,000 persons. Most emigrants to the metropolis from affected homelands did not change their registration for the information of homeland's recovery and reconstruction. If job and home recovery in affected homeland is implemented in a

few years, it is believed that they will come back to homelands. Therefore, it is necessary to quickly recover economic activities to pre-disaster levels.

In addition, it is even more important to regenerate and grow industry to 130 % of pre-disaster economic levels for nation's preparedness against next great disaster. Only the revitalization of economic activities as national strategy can create a variety of new jobs and increase the population of East Japan.

Based on the trend after the tsunami, it is very difficult to recover jobs and population rapidly in the affected areas. Plains and valleys of the central and other districts subsided after the mega earthquake. For redevelopment of new industrial zones, it is necessary to build up sunken lands with tsunami banks. Such improvement requires a tremendous volume of soil. However, there is no soil available, because highland development for new housing sites has not been implemented, despite 2 years having elapsed after the tsunami.

As an immediate aim of recovering affected areas, the population must be recovered to pre-disaster trends. As a long-term reconstruction goal in Northeast Japan, the population must not only be recovered, but grown to 130 % of the pre-disaster population.

The 130 % post-disaster recovery and reconstruction goals for the East Japan affected areas are necessary for recovery following the next great disaster in Japan, such as northern Tokyo Bay earthquake or Nankai Trough earthquake.

3.2 The Seismic Situation in Twenty-First Century Japan

We must recover and reconstruct damaged East Japan areas as quickly as possible. However, the probability of another severe earthquake and tsunami disaster is increasing in central and western Japan (Fig. 13). Ministry of Education, Culture, Sports, Science and Technology announces that the probability in the next three decades of a northern Tokyo Bay earthquake is 70 % and that of a Nankai Trough (Tokai, Tonankai and Nankai) earthquake is 60–87 %. Damages of two earthquakes are estimated by National cabinet (Table 8). It is imperative that Northeast Japan, the Tokyo National Capital Region and West Japan support each other. Recovery and reconstruction of first region is supported by the activities of the latter two. In the decade following the great East Japan earthquake, north East Japan must be supported by Central Japan (Tokyo metropolitan area) and West Japan. To overcome the adversity of future great earthquake disasters, the 130 % reconstruction goal of north East Japan must be met in the coming decade. The 100–80 % reconstruction goal is too short to support the affected area by next great earthquake.

3.3 National Development Strategy of Dual Recovery—Post-Disaster and Pre-Disaster Recoveries

Given the seismic environment, we must remake and recognize the national structure of Japan by post-disaster recovery and reconstruction of tsunami-affected parts of

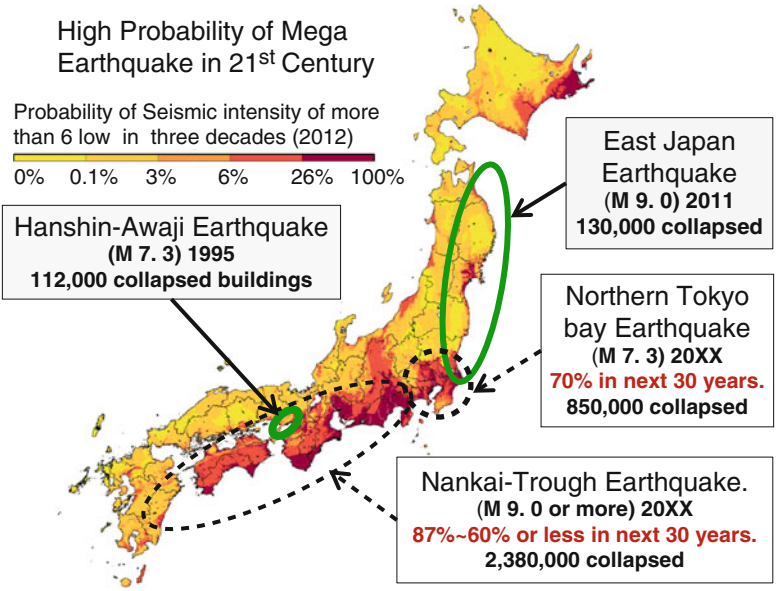

Fig. 13 Areas with high probability of next great earthquake and tsunami disaster

Table 8 Damages of previous great earthquakes and estimated damages of forecasting great earthquakes

Name of earthquake		Nankai Trough (National Cabinet 2013)	Northern Tokyo Bay (National Cabinet 2005)	East Japan (National fire agency 2012)	Hanshin-Awaji (Hyogo prefecture 1997)
Occurred or estimated		2012(est.)	2005(est.)	11 March 2011	17 January 1995
Richter magnitude		9.0 or more	7.3	9.0	7.3
Location of epicenter		Trough	Inland	Trough	Inland
Wind speed		8 m/s	15 m/s	Not strong	3 m/s
Season and time		Winter, evening/ night	Winter evening/ noon	Winter afternoon	Winter early morning
Casualty	Killed and missing	320,000	11,000	18,600	5,500
	Injured	–	240,000	6,100	44,000
Building collapsed	Severely(shake)	1.63 million	200,000	129,400	105,000
	(Tsunami)	146,000	0		0
	Moderately	–	–	254,200	144,000
	Burned by fire	750,000	650,000	Unknown	7,400
	Severely total	2.4 million	850,000	129,400	112,400
Refugee in shelter		9 million	7.5 million	470,000	320,000
Unable to come home		–	6.5 million (noon)	More than 5 million	A few (early morning)
Economic losses (yen)		220 trillion	112 trillion	25 trillion	10 trillion

the northeast (especially coastal areas in the Tohoku region), and by pre-disaster recovery and reconstruction of Central Japan (TMA) and West Japan. This embodies the idea of "dual recovery", post-disaster and pre-disaster. Table 9 is a scenario of dual recovery grand design for reconstructing and reorganizing the national structure. For this dual recovery to succeed, four concepts are important: (1) expansion and combination; (2) smart downscaling and revitalization; (3) coordination and collaboration; and (4) safety and security.

We shall reorganize the country not only through post-recovery as rapidly as possible in northern east Japan, but also with continuous pre-disaster recovery in central and western Japan. We must have such a national development strategy to promote the dual recovery concept, through collaboration with people, local and industrial communities and all governments.

4 Pre-Disaster Recovery from Future Mega Earthquake Disasters in Tokyo MA and West Japan

4.1 Pre-Disaster Recovery Schemes for a Future Tokyo Earthquake

The concept of the temporary town project in the recovery and reconstruction approach was proposed by the Tokyo Metropolitan Government (TMG), using lessons learned from the 1995 Hanshin-Awaji earthquake disaster. To recover from the tremendous damage estimated by TMG in 2006, which only in Tokyo was five times that of the 1995 event, it was necessary for TMG to prepare the "a Design Urban Reconstruction" (TMG 2001) and "Guide Line for Post-disaster Recovery Approach"(TMG 1997) (Figs. 14 and 15).

Figure 14 shows the proposal of seven strategic urban reconstruction projects, based on the report entitled "Damage Estimation of the Next Tokyo Earthquake" TMG. The grand design was announced in 2001 and has been available on the TMG website. For reconstruction of Tokyo from the next earthquake, the seven projects are presented previously as follows (1) Arrangement of "safer residential districts with fireproof buildings and community facilities" in the crowded wooden housing districts surrounding central Tokyo, where earthquake fires can destroy houses; (2) redevelopment of "safer ring zones with green open spaces" in the aforementioned districts (3) construction of "large parks as backup bases for residential districts" for future earthquake disasters; (4) adjustment of the below-sea-level zones to "safer ground reclaimed using rubble collapsed by earthquake; (5) "construction of important road networks" for the metropolis; (6) "rearrangement of river and canal waterfronts"; and (7) enlargement of the international business center of Tokyo."

Figure 15 shows the conceptual model of recovery and reconstruction process following the next Tokyo earthquake, that was revised from the 1997 guide line and proposed by the TMG in 2003. The crowded wooden housing districts surrounding

Table 9 Scenario of dual recovery and reconstruction grand design for Japan

	Post-disaster recovery in northern east Japan (EJ)	Pre-disaster recovery in central Japan (Tokyo metropolitan area) and western Japan (CJ and WJ)
2011–2013: period of rapid recovery and reconstruction of EJ and preparedness of pre-disaster recovery on TMA/WJ	Urgent post-disaster recovery Reconstruction of damaged towns and villages Subjective recovery of damaged communities and direct aid from national and prefectural governments Focus on recovery of six affected prefectures (Aomori, Iwate, Miyagi, Fukushima, Ibaragi and Chiba) Redevelopment of basic infrastructure, preparing for re-growth of EJ	Direct support for EJ recovery Manpower and donations from public and private sectors Preparedness and urgent operation of pre-disaster recovery Anti-earthquake and anti-tsunami reinforcement of atomic power plants and thermal power stations Damage reduction of crowded urban areas, coastal towns and coastal villages
2014–2016: period of reconstruction and regrowth of EJ and progress of pre-disaster projects of TMA and WJ	Progress of post-disaster recovery Six prefectures in Tohoku Region (EJ) invite various enterprises from WJ and TMA to EJ Subjective re-growth of damaged community and indirect aid from national and prefectural governments	Progress of pre-disaster recovery Inducement to relocate various industries to EJ as pre-disaster recovery action of WJ and TMA Introduction of economic recovery zone in East Japan for relocation of industries from WJ and TMA
2017–2020: period of expansion of growth in EJ and acceleration of pre-disaster recovery of TMA and WJ	Subjective expansion of EJ Economic expansion in whole of EJ at greater rate than pre-disaster Subjective expansion of private sector Establishing EJ as a support for WJ or TMA during disaster	Achievement of pre-disaster recovery in WJ and TMA Reduction of damage by half and its increase Vitalization of WJ, TMA and EJ to support each other during next disaster
2020–: period of maturity	Reorganization of national structure; EJ, Central Japan and WJ act as supports for one other during subsequent great disaster Establishment of green Japan model, that is, low-energy, high-performance cities	

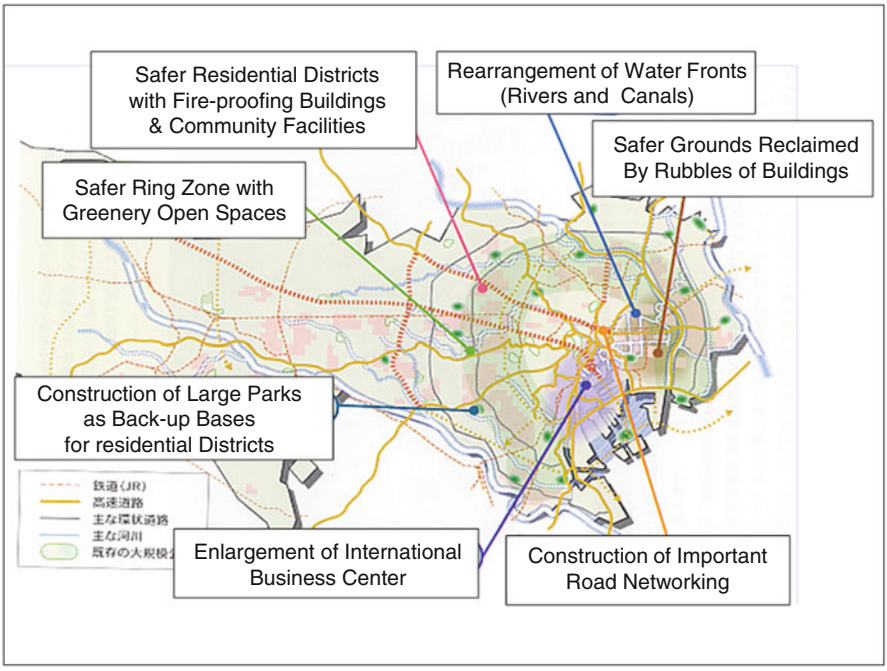

Fig. 14 Strategic recovery projects proposed by TMG (Tokyo Metropolitan Government 2001)

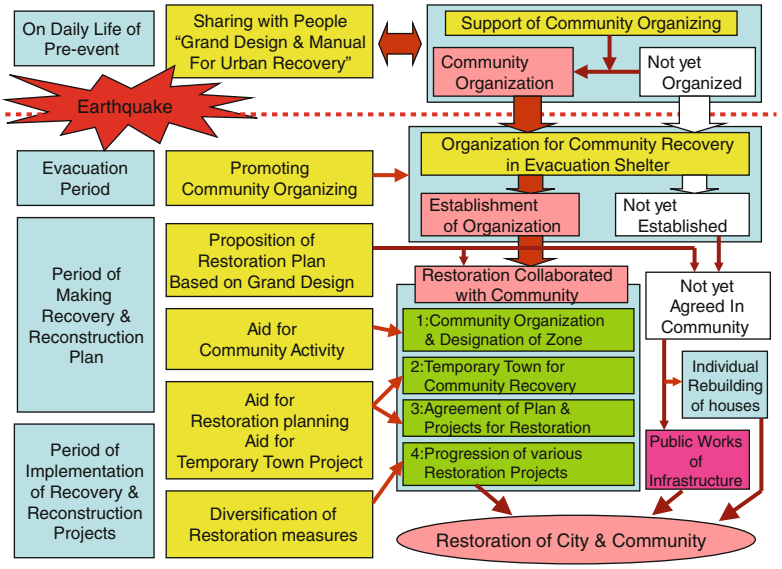

Fig. 15 Recovery process after next Tokyo earthquake, proposed by TMG (2003b)

Central Tokyo are the most vulnerable to collapse and burning following an earthquake. In these districts, reconstruction of "safer residential districts with fireproof buildings and community facilities" shall be implemented. To recover and rebuild the city after a future earthquake as soon as possible, collaboration with citizens and business has been proposed. In addition to the pre-disaster presentation of reconstruction grand design, guide line has been proposed to plan a recovery and reconstruction project quickly and consent such project as rapidly as possible in a community.

It is not enough for only to make and announce a guide line. If a guide line is put on a book case, people pass it out of minds. In Tokyo, both practice of officials and movement of community revitalization through "pre-disaster reconstruction exercise" has carried out by local government. Since 1998, practices of earthquake recovery guide line continue to be carried with about 80 officials of local jurisdictions by TMG. More than 1,200 officials have become practiced until 2012. Additionally, since 2003, the community-based exercise has been implemented in more than 40 districts. Further, 19 of 23 local ward governments have prepared earthquake reconstruction guide lines and manuals in the event of future Tokyo earthquake.

In the recovery process announced by the TMG, the concept of the temporary town project is important in job recovery, sustaining community activities and coming up with the community recovery and reconstruction plan in collaboration with local government. As a lessons from the Hanshin-Awaji earthquake, recovery and reconstruction process management in a community is also very important to sustain a community and survival all of residents. The first step of temporary town project is a set up of temporary town to livelihoods and jobs as soon as possible. Temporary town will be set up in a collapsed residential district. People, especially owner-occupiers, will continue to stay in a town with community. Shops, small offices and works also will stay in a town in temporary facilities. Therefore, TMG and local governments will rent whole lands of a town temporarily for 2 years or more. It is a step of transition from the damaged areas to temporary towns. The second step is continuously reconstructed permanent towns temporary towns, through collaboration of residents, the community and governments (Figs. 16 and 17).

In addition to preparedness of community-based recovery and reconstruction measures (grand design, guide line, manuals and community-based exercises), reconstruction projects such as widening of narrow streets, land readjustment in crowded urban areas, establishment of small parks, and others, which are post-disaster reconstruction projects following a future earthquake, must be implemented before a disaster. According to damage estimates, local government formulates a community-based recovery and reconstruction plan in collaboration with residents before a disaster. To collaborate with a community for preparedness of recovery and reconstruction plan and implementation of this plan, the pre-disaster recovery exercise is very effective and has been implemented in every crowded wooden housing district of central Tokyo. At least, it must be implemented as soon as possible to adjust and confirm boundary of land in crowded housing districts before a disaster. It is the most important first step of pre-disaster reconstruction project in Japan.

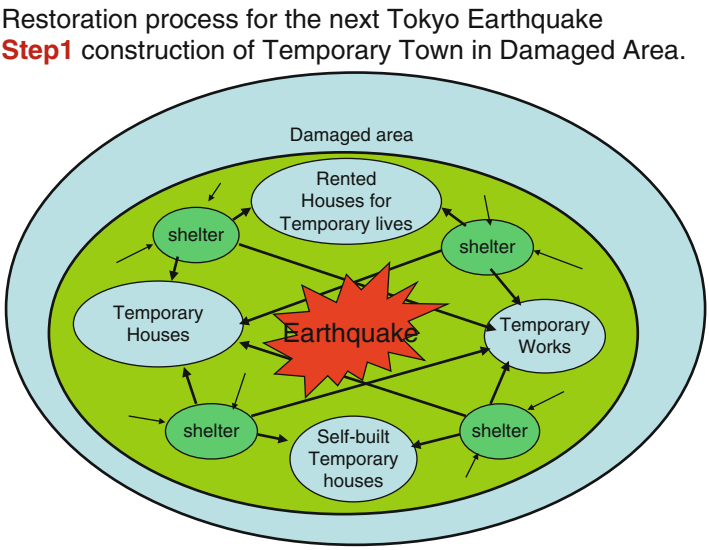

Fig. 16 Temporary town project (step 1), proposed by TMG (Tokyo Metropolitan Government 2001; TMG 2003a)

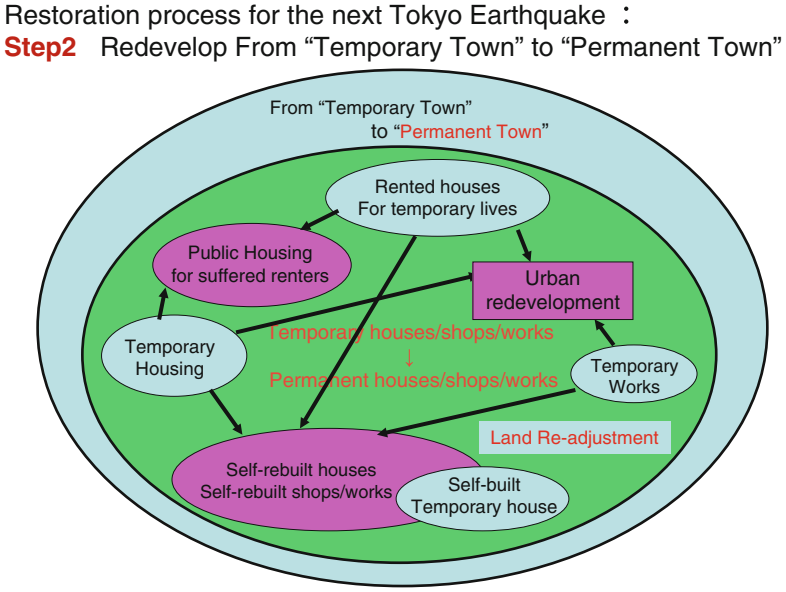

Fig. 17 Temporary town project (step 2), proposed by TMG (Tokyo Metropolitan Government 2001; TMG 2003a)

4.2 Pre-Disaster Recovery Strategy for a Nankai Trough Mega Earthquake

In Table 8, the damages from Nankai Trough earthquake will be coursed by strong motion, burning following earthquake and tsunami. According to damage estimates by the national cabinet, more than 1,600,000 buildings could collapse, 750,000 could burn down, and approximately 150,000 would be destroyed by a worst-case tsunami. In such a scenario, more than 320,000 people could be killed, mainly by a tsunami striking around midnight.

The most important pre-disaster recovery project for saving lives is the relocation of houses from lowlands to highlands in the decades preceding a Nankai Trough mega earthquake. It is unnecessary before a disaster to serve people in shelters and to build numerous temporary houses. Even if houses are relocated to highlands after a disaster like the East Japan mega earthquake, more than 320,000 people could still be killed by a Nankai Trough earthquake-related tsunami. Pre-disaster recovery is more effective and necessary in western Japan.

The other important project for reduction of houses collapsed by earthquake and fire following it is the renewal of old houses built before 1981, when a seismic design codes of Building Standard Law was intensified. If all buildings are built under the 1981 codes, is estimating that a destruction of 2.3 million buildings by shaking and burning reduces to 100,000 buildings. It is limitable to intensify old buildings through retro-fitting. It is important to promote a reconstruction of old buildings as a earthquake-proof and fire-proof buildings in the decades.

In western Japan, every local government must prepare a grand design and planning guide line for post-disaster recovery and reconstruction. In each community, a pre-disaster recovery and reconstruction exercise must be promoted. In addition to damage prevention and preparedness of damage mitigation, pre-disaster recovery and reconstruction measures must be established as soon as possible.

5 Concluding Remarks—Japan 50 Years in the Future

The East Japan mega earthquake has changed the national development strategy. The other mega earthquakes must occur in the twenty-first century in Japan. In this decade, recovery from the East Japan mega earthquake must be completed as rapidly as possible. However, recovery from East Japan mega earthquake has been supported by the activities of Tokyo Metropolitan Area and western Japan. In the case of a future Tokyo earthquake, post-disaster recovery of Tokyo Metropolitan Area must be supported by both western and eastern Japan. Also in the case of a Nankai Trough earthquake, post-recovery of western Japan must be supported by eastern Japan and the MA.

The national structure of Japan must be constituted so that the nation is sustained by mutual support between eastern Japan, western Japan and central Japan

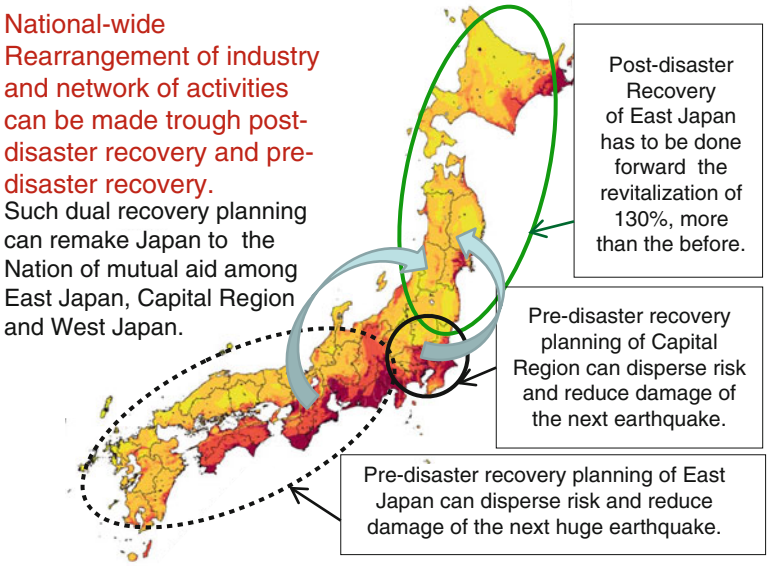

Fig. 18 Dual recovery project for creating national resilience through rearrangement of industry

(Metropolitan Area as National Capital Region). Therefore, it is imperative that domestic economic activities must be revitalized in whole of Japan. Various industries should be relocated to eastern Japan rather than overseas. Such industry relocation from western Japan and central Japan to eastern Japan represents a disaster prevention measure that spreads risk across industrial sectors (Fig. 18). And also various central functions must be spread from Tokyo, Osaka and Nagoya Metropolitan Areas to the others. As a result, people will be spread from metropolitan areas to whole regions.

Reconstruction of eastern Japan following mega earthquake is not recovery and reconstruction of affected areas but new development of a nation restructuring. The dual recovery and reconstruction project for creating a newly restructured Japan can make it more resilient. The recovery of Fukushima can also progress and can be an important part of a new Japan because the probability of establishing new industries in Fukushima is very high. New technological industries of new energy sector including nuclear waste processing technology shall remake new Fukushima in future.

Historically, it is repeated to recover and reconstruct from compound mega disasters in Japan. There were many cases of more severe than the 2011 East Japan mega earthquake. In 2050s, population on Japan will decrease less than 100 million and will progress high aging society. In the former half of twenty-first century, redevelopment and restructuring of Japan must be promoted steadily. Pre-disaster recovery and reconstruction is key-concept to remake new Japan.

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Developing Resilient Infrastructure as a Basis for Restoration from the Great East Japan Earthquake

Mikiko Ishikawa

Abstract The Great East Japan Earthquake occurred on 11 March 2011. In the following 2 years, municipal reconstruction plans were established for most of the affected regions. However, the actual process of the reconstruction is very slow. To ensure sustainability in the region, it is essential to identify problems in the existing restoration plans and establish a set of principles that could be shared as common goals within the community. Based on this perspective, this chapter focuses on three points: (1) the characterization of the damaged areas from natural, historical, and social points of views; (2) the assessment of the municipal reconstruction plans to identify safety and sustainability problems; (3) the introduction of resilient infrastructure as a basis of the reconstruction.

In this chapter, a hypothesis of resilience is established, based on the concept of environmental, social, and cultural sustainability. Using a case study of the small city of Iwanuma in Miyagi Prefecture, specific examples of the struggles involved in the planning process are shown, and the future of resilient infrastructure planning to achieve sustainability in the region is discussed.

Keywords Great East Japan Earthquake • Tsunami • Restoration • Resilient infrastructure

M. Ishikawa (✉)
Department of Integrated Science and Engineering for Sustainable Society,
Faculty of Science and Engineering, Chuo University 1-13-27 Kasuga Bunkyo-Ku,
Tokyo 112-8551, Japan
e-mail: ishikawa.27w@g.chuo-u.ac.jp

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1 Regional Characteristics

1.1 Geological Characteristics of the Region

The Great East Japan Earthquake of 11 March 2011 resulted in 15,879 confirmed dead and 2,712 missing. The epicenter was off the coast of Sanriku-Oki and the magnitude was 9.0. After the earthquake, a devastating tsunami hit the east coast of Japan in Aomori, Iwate, Miyagi, Fukushima, and Ibaraki prefectures. The most heavily damaged areas were Iwate, Miyagi and Fukushima prefectures. Differences in the geological characteristics of three prefectures are the main reason why post-tsunami restoration varies from place to place (Fig. 1).

The section of the coast extending from Sanriku in Iwate Prefecture to the northern part of Miyagi Prefecture is characterized by rias. The tsunami hit particularly hard in the narrow bays found here, and resulted in tsunami heights of over 20 m; many villages completely disappeared. Numerous historical records of tsunami exist in the area, particularly from the Meiji Sanriku tsunami of 1896 (Fig. 2), and the Showa Sanriku tsunami of 1928.

A clear "tsunami edge" also exists (Figs. 3, 4, and 5). Below the highest line of the tsunami, everything was strongly destroyed, but above that line, nothing had changed. Therefore, theoretically, the main principal for restoration in the coastal areas dominated by rias is to remove infrastructure from the upper area. Since the Meiji era, much restoration work has been carried out; this has basically involved moving to higher land. However, given Japan's terrain, developable lands are limited, and of course, fishing villages are closely related with the ocean, so over time, people gradually returned to the seashore.

The central to southern coastal area in Miyagi Prefecture consists mainly of alluvial flats, which were created by big rivers: specifically the Kitakami, Nanakita, Hirose, Natori, and Abukuma rivers. In this area, records of tsunami exist for the Jogan Earthquake of 869 and the Keicho Earthquake of 1,605. Since then, this area had not been hit by a huge tsunami, therefore municipalities and citizens were not as aware of the risk of a possible tsunami. Consequently, many people died and infrastructure was substantially damaged. Because there is no higher land adjacent to the destroyed area (Figs. 6 and 7), it is difficult to determine the best course of action for reconstructing safe towns.

Fukushima Prefecture differs from its neighbors in that ; Abukuma Mountain is located along the seashore. As there were few remaining flat areas, the nuclear plant was constructed on the coast. Because of the problems associated with the nuclear disaster at Fukushima, the restoration process is completely different.

In this chapter, the restoration process and plans in Iwate and Miyagi prefectures are the main focus.

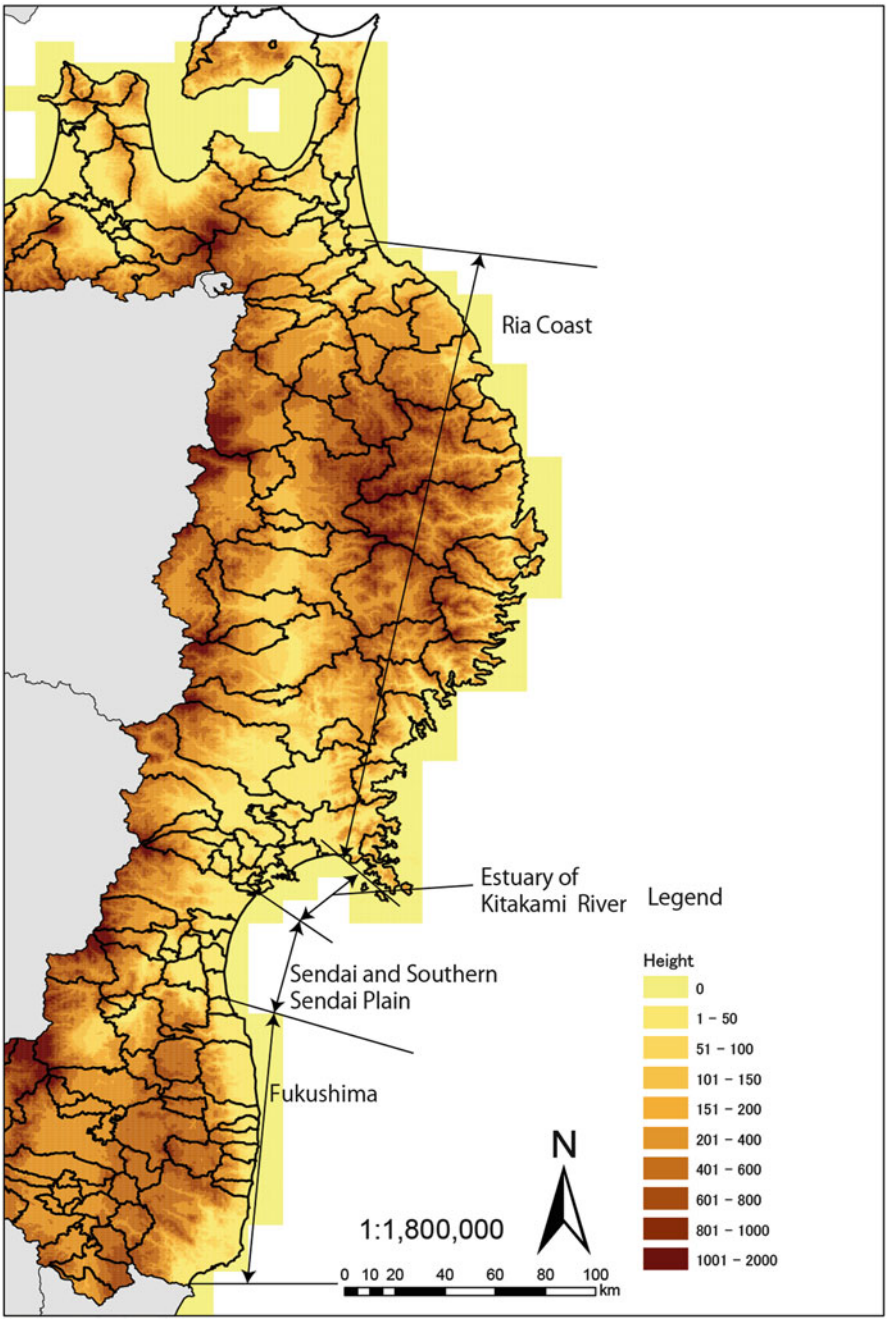

Fig. 1 Geological characteristics of the area damaged by the Great East Japan Earthquake

Fig. 2 Meiji Sanriku Tsunami (*Source*: Fuzokugaho No.119, Special Edition on the Great tsunami of June 25, 1896)

Fig. 3 Rikuzen-Takada City (after Tsumani, April 2011)

Fig. 4 Tsunami Edge in Rikuzen-Takada

Fig. 5 Tsunami Edge in Rikuzen-Takada

1.2 Social Characteristics of the Region

Table 1 shows the number of the dead and missing, the population dynamics, and the growing percentage of elderly generations in the tsunami affected region.

Fig. 6 Tsunami damaged area

Fig. 7 Tsunami damaged area in Sendai Alluvial Flats

Total population in the region is 2,510,000. Only the city of Sendai has a population of over 1,000,000 people. Other cities are Iwaki (340,000), Ishinomaki (160,000), Kesen-numa (73,000), and Miyako (59,000). There are also numerous towns in Iwate Prefecture, mostly fishing villages with populations of 3,000–20,000.

Table 1 Number of the dead and missing, the ratio of elderly people, population change

	Names of municpalities	Number of the dead	Rate of the dead (%)	Number of the missing	Number of collapsed building	Elderly population	Rate of elderly population (%)	Population under 65 yrs old	Total population	Rate of population increase (2005–2010) (%)
Iwate Pref.	Myako City	420	0.7	107	4,675	18,363	30.9	41,067	59,430	−6.5
	Oofunato City	340	0.8	84	3,629	12,552	30.8	28,185	40,737	−6.0
	Kuji City	2	0.0	2	277	9,718	26.4	27,154	36,872	−5.8
	Rikuzenn–Takata City	1,555	6.7	240	3,341	8,125	34.9	15,175	23,300	−5.7
	Kamaishi Town	888	2.2	158	3,648	13,772	34.8	25,802	39,574	−7.9
	Ootuchi Town	803	5.3	479	3,717	4,948	32.4	10,328	15,276	−7.5
	Yamada Town	604	3.2	153	3,167	5,927	31.8	12,690	18,617	−7.6
	Iwaizumi Town	7	0.1	0	200	4,084	37.8	6,720	10,804	−9.3
	Tohota Village	14	0.4	15	200	1,301	33.9	2,542	3,843	−9.4
	Fudai Village	0	0.0	1	270	973	31.5	2,115	3,088	−8.0
	Noda Village	38	0.8	0	0	1,393	30.1	3,239	4,632	−7.7
	Hirono Town	0	0.0	0	479	5,467	30.5	12,446	17,913	−8.3
Miyagi Pref.	Sendai City	797	0.1	32	26	191,722	18.3	854,264	1,045,986	2.0
	Ishinomaki City	3,182	2.0	553	191,722	43,747	27.2	117,079	160,826	−3.9
	Shiogama City	31	0.1	1	43,747	15,493	27.4	40,997	56,490	−4.8
	Kesennnuma City	1,032	1.4	324	15,493	22,600	30.8	50,889	73,489	−5.8
	Natori City	911	1.2	55	22,600	13,945	19.1	59,189	73,134	6.5
	Tagajyo City	188	0.3	1	13,945	11,531	18.3	51,529	63,060	0.5
	Iwanuma City	181	0.4	1	11,531	8,723	19.7	35,464	44,187	0.6
	Higahsi-Matsushima City	1,047	2.4	58	8,723	9,932	23.1	32,971	42,903	−0.8
	Watari Town	257	0.7	12	9,932	8,078	23.2	26,767	34,845	−0.8
	Yamamoto Town	671	4.0	19	8,078	5,284	31.6	11,420	16,704	−5.7
	Matsushima Town	2	0.0	0	5,284	4,654	30.9	10,431	15,085	−6.8
	Sichirigahama Town	72	0.4	4	4,654	4,400	21.6	16,016	20,416	−3.1
	Rifu Town	23	0.1	0	5,526	5,526	16.3	28,468	33,994	5.4
	Onagawa Town	575	5.7	340	3,362	3,362	33.4	6,689	10,051	−6.3
	Mimami Sanriku Town	565	3.2	280	5,238	5,238	30.1	12,191	17,429	−6.5

(continued)

Table 1 (continued)

	Names of municpalities	Number of the dead	Rate of the dead (%)	Number of the missing	Number of collapsed building	Elderly population	Rate of elderly population (%)	Population under 65 yrs old	Total population	Rate of population increase (2005–2010) (%)
Fukushima Perf.	Iwaki City	310	0.1	37	38,508	85,510	25.0	256,739	342,249	−3.5
	Soma City	458	1.2	0	1,782	9,577	25.3	28,240	37,817	−2.1
	Minami-Soma City	631	0.9	7	6.738	18,809	26.5	52,069	70,878	−2.7
	Hirono Town	2	0.0	1	Unknown	1,288	23.8	4,130	5,418	−2.1
	Naraha Town	37	0.5	0	Unknown	1,995	25.9	5,705	7,700	−6.0
	Tomioka Town	91	0.6	3	Unknown	3,342	20.9	12,659	16,001	0.6
	Ookuma Town	46	0.4	1	Unknown	2,413	21.0	9,102	11,515	4.8
	Futabe Town	55	0.8	1	83	1,879	27.1	5,053	6,932	−3.3
	Namie Town	182	0.9	2	614	5,548	26.5	15,357	20,905	3.3
	Shinchi Town	115	1.4	0	566	2,215	26.9	6,009	8,224	−4.2

Data Source 1: Comprehensive Disaster Prevention Room, General Affairs Department, Iwate Prefecture. 17:00 12 March 2012 (2012)
Data Source 2: Section of Crisis Measures, General Affairs Department, Miyagi Prefecture. 17:00 11 March (2012)
Data Source 3: Disaster Response Headquarters, Fukushima Prefecture. 8:00 12 March 2012 (2012)
Data Source 4: National Census 2010

Cities and towns in the central and southern areas of Miyagi Prefecture are basically agricultura, but because of the rapid urbanization beginning in the 1960s, housing and industrial developments occurred in metropolitan Sendai. Cities such as Tagajyo, Rifu, Natori, and Iwanuma, located within the metropolitan Sendai region, have born the brunt of the population increase. In Fukushima, population increase in the cities of Tomioka and Okuma was driven by the location of the Fukushima Daiichi Nuclear Plant. Many towns, especially along the rias coastal area in northern Miyagi and Iwate prefectures, are now faced with a rapid population decrease (Figs. 8 and 9).

Figure 10 shows the percentages and distribution of elderly people in the area. In villages and towns in Iwate, such as Noda, Fudai, Miyako, Kamaishi, and Rokuzen-takada, over 30 % of the population is elderly. In metropolitan Sendai, this percentage is 16–20 %, and in Fukushima it is 20–25 %. Generally speaking, towns and villages far from the core city in each region, such as Minamisanriku, Onagawa, Yamamoto, and Shinchi have experienced an increase in the number of elderly inhabitants (Fig. 11).

2 The Restoration Process

2.1 Regional Restoration

The process of restoration following the Great East Japan Earthquake has been very slow. The main reason for this was the serious and complicated accident at the Fukushima Daiichi Nuclear Plant. It took 3 months for the Fundamental Law of the Restoration to be enforced (23 June 2012). In that time, the roles of the national and local municipal governments were established, initial financing for the restoration was secured, a special district was introduced, and a Ministry of Restoration was decided to establish.

Based on this Fundamental Law, strategies for restoration implementation were established on 29 July 2011. It nevertheless took 8 months for the Ministry of Restoration to be finally established on 10 February 2012, and it is still not working effectively because of barriers between existing jurisdictions.

It may be useful to review when each municipality started its own restoration plan, and how each decided to implement it. Figure 12 shows the date when each restoration plan was established. Even in this crisis, some municipalities started to make their own restoration plan, without waiting for help from the national government; these included small villages in Iwate (Hirono, Kiji, Fudai, and Iwaizumi), Onagawa, Iwanuma, and Soma. These towns and cities established their restoration plan within 6 months following the tsunami. The leaders of those cities considered that the safety of refugees' lives required immediate action. They decided to plan their own restoration first and establish goals for implementation, without waiting for decisions from the national government.

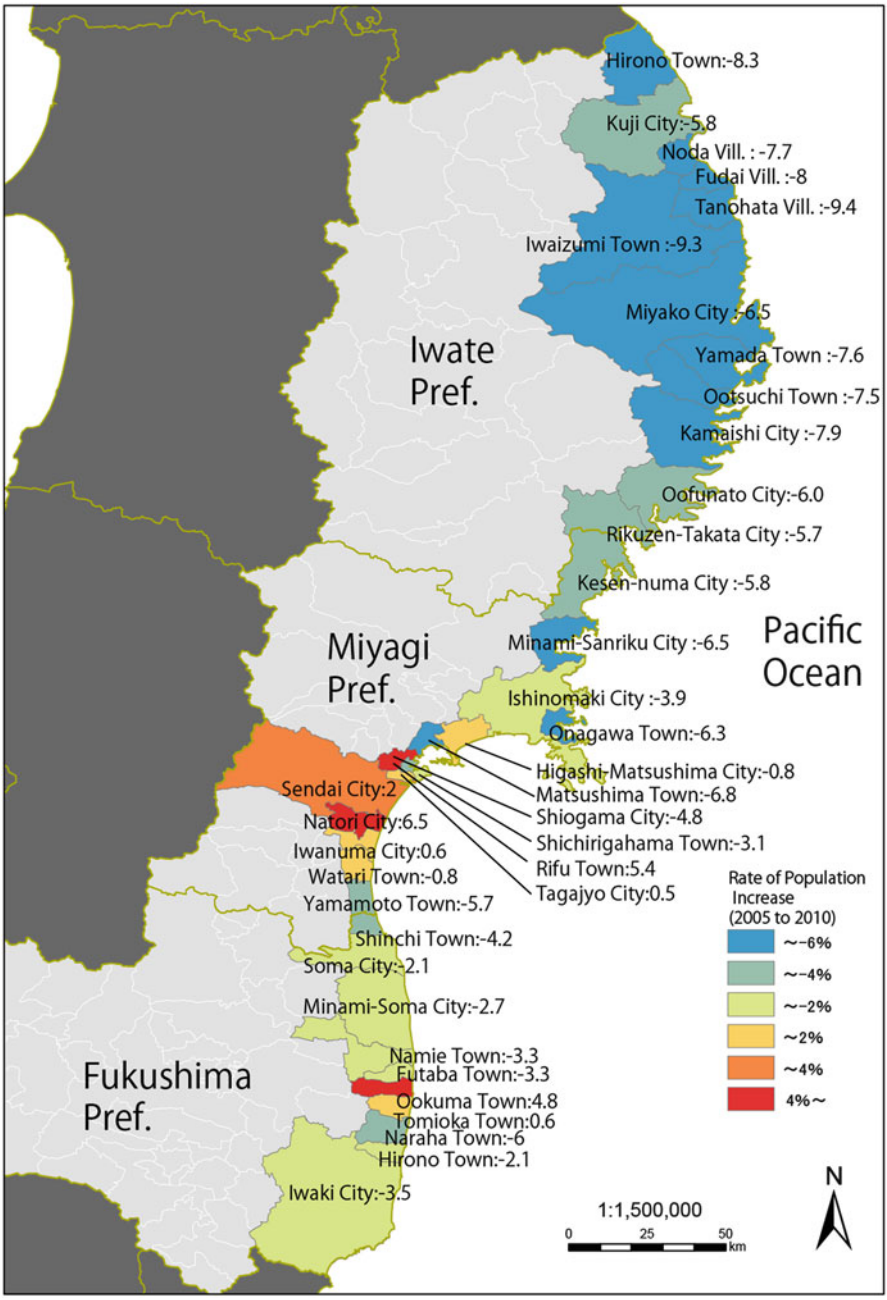

Fig. 8 Population dynamics ratios

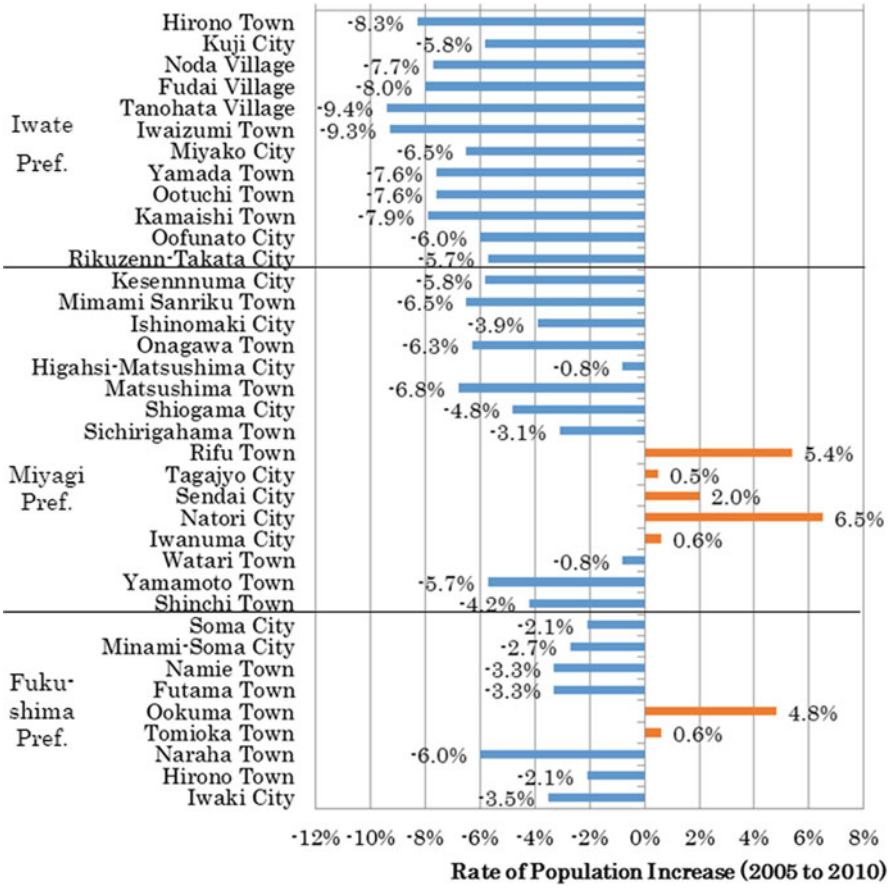

Fig. 9 Population dynamics ratios

However, most cities basically had to wait until the national government released information concerning required heights of seashore banks. Particularly in the area of the Sanriku rias, successful new land use plan should designate dangerous areas from where people have to move. The tsunami simulation models conducted by the national government took 6 months to calculate. Therefore, many cities and towns simply had to wait without being able to identify new steps. Consequently, it was impossible to find the future of community, and the younger generation tended to leave villages while the elderly remained. The delay beginning restoration work notably causes permanent demographic changes in community. This provides an important lesson as preparations for a Tokai, Tonannkai, and Nankai Earthquake are considered. As for Fukushima, after 2 years, a clear vision for the restoration has still not been determined.

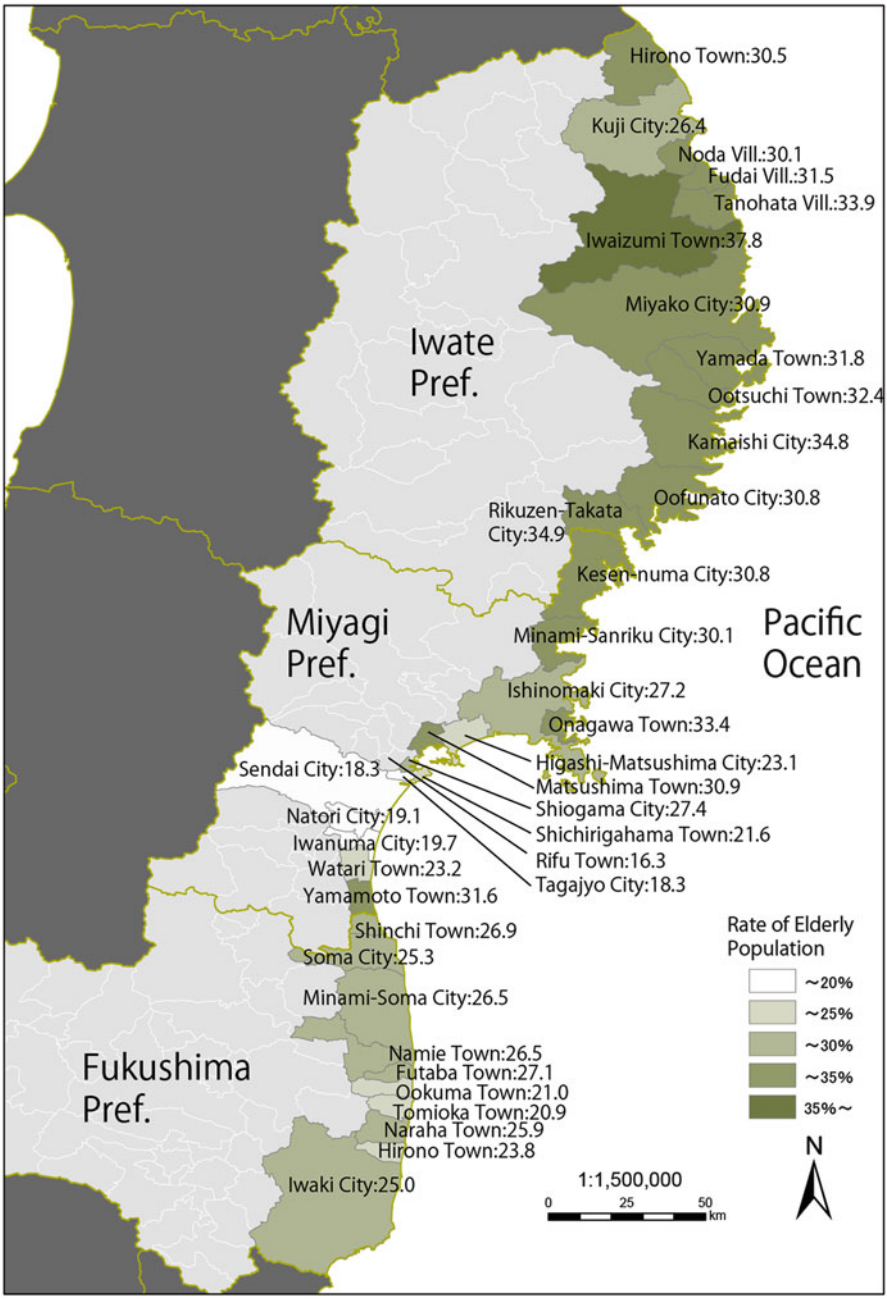

Fig. 10 Percentage of elderly people

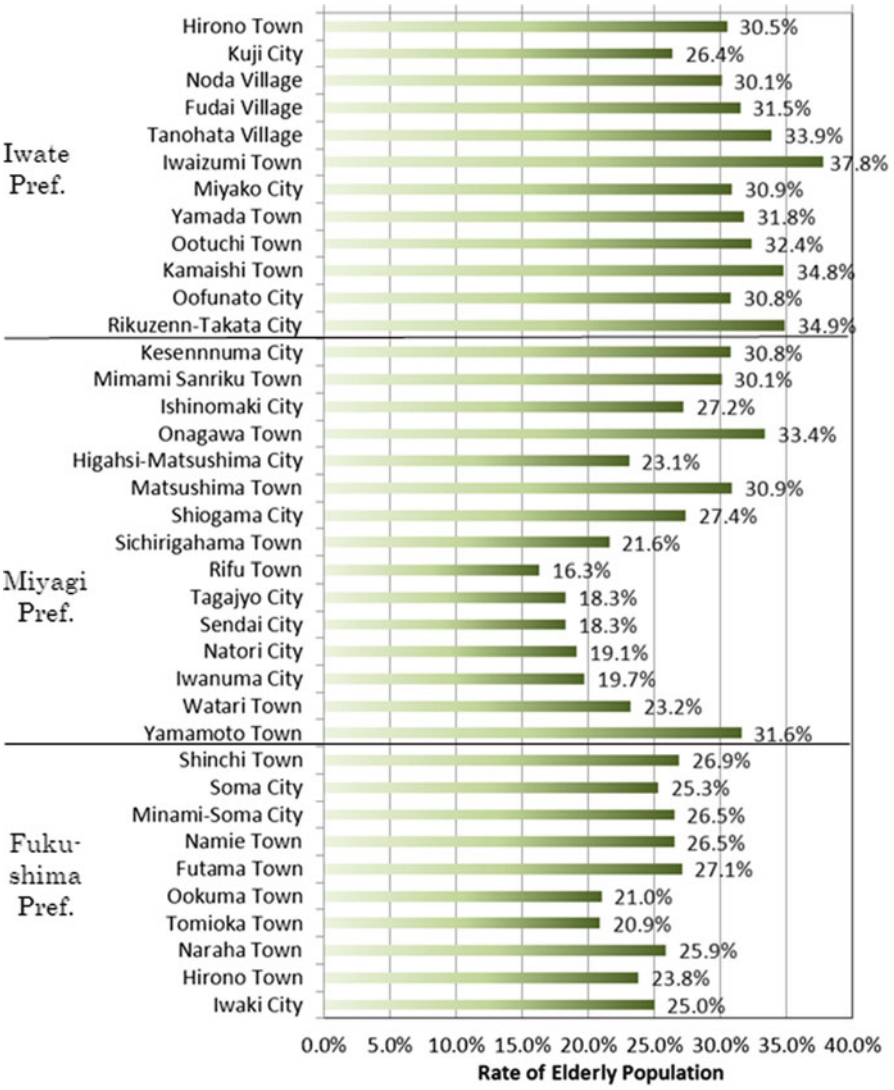

Fig. 11 Percentage of elderly people

2.2 Post-Tsunami Restoration Patterns

Restoration pathways fall into three basic types. The first concerns the coastal areas characterized by rias, where the seashore area would be designated as a disaster danger area, where housing would be prohibited. Figure 13 shows a diagram depicting a "Community Removal Project" (CRP) for preventing disasters in such regions.

Fig. 12 Date of the establishment of restoration plan

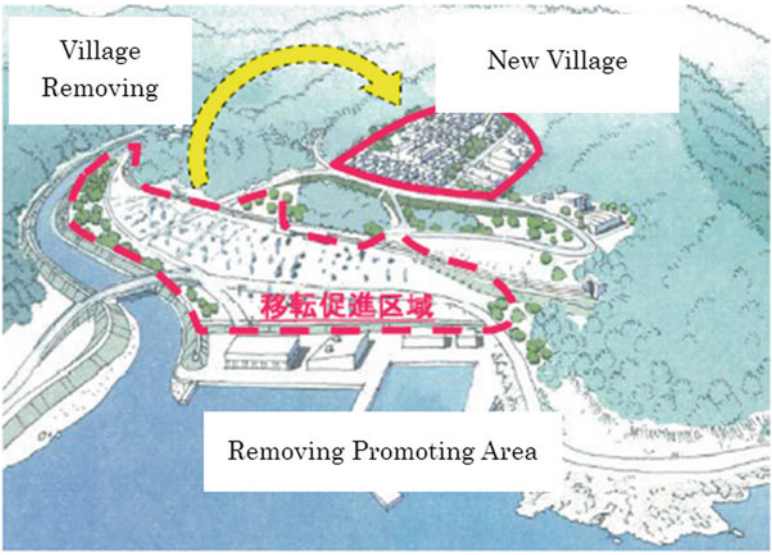

Fig. 13 Community Removal Project (*Source*: Ministry of Restoration, the existing Conditions of the Restoration, Dec. 2012)

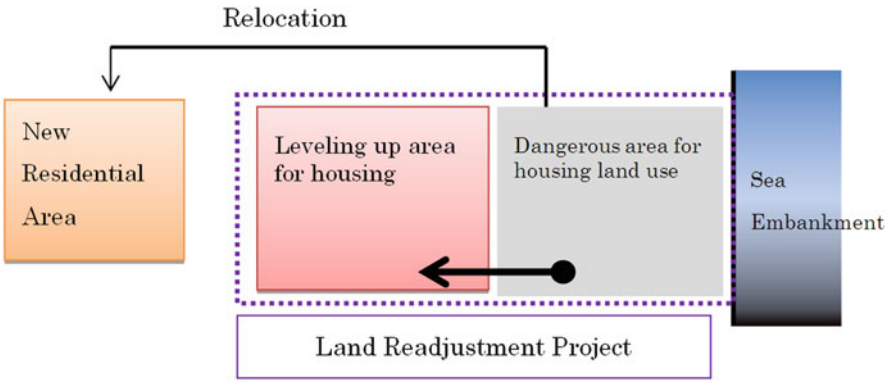

Fig. 14 Combination of Community Removal Project and Land Readjustment Project

In a CRP, new residential areas are expected to be established in higher areas. However, in this region the actual adjacent hillsides are very steep, and flat building sites are not common. Therefore, Fig. 14 shows that certain areas currently lying within the seashore area will have to be raised up to form land that will be used as a residential zone. In this case, because the raised area has a complicated existing land use, a so called "Land Readjustment Project" (LRP) would be introduced. To implement a CRP, it is essential that all members of the community agree to the removal. However, attaining such agreement can be unrealistic, and may lead to

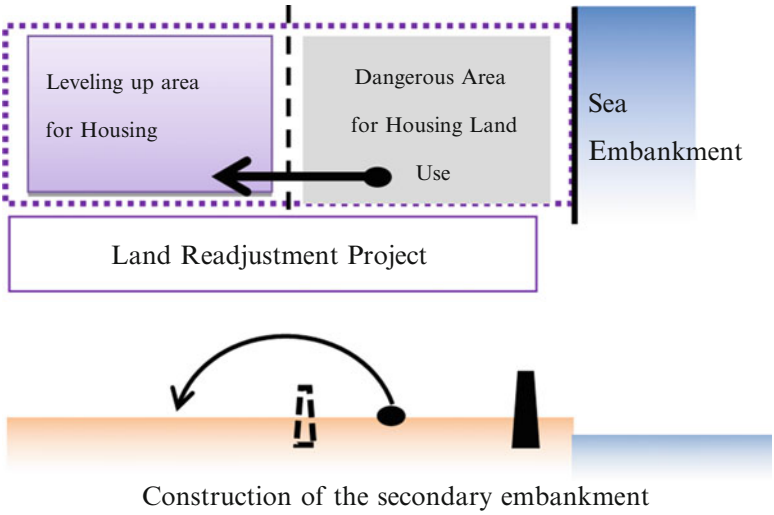

Fig. 15 Land Readjustment Project involving the introduction of a secondary embankment

municipalities starting to admit exceptional cases. Implementation of a LRP is even more difficult. Considerations of the many people who died in the area and the original territory of houses and buildings that have since disappeared will act barriers to site selection and implementation in such a plan. Considering the range of difficulties to be faced, new restoration methods must be developed that are consistent with the huge scale of the disaster and the rapid recovery for all refugees.

Figure 15 shows a second pattern for the restoration. This method has been introduced to the alluvial flats area in Miyagi Prefecture, where no higher land exists adjacent to the damaged city. In this case, to secure the future city from tsunami, a secondary embankment would be necessary. A technical problem lies in the lack of an adequate technical standard for secondary embankments. Because this area is huge, and the first sea embankment is now in a process of construction. The municipality must consider the cost and effectiveness of a secondary embankment. Additionally, much debate is ongoing among the ordinary inhabitants of the region. The younger generation (e.g., those who have families), generally oppose the rebuilding of houses where the tsunami struck, often citing mental stress on children. Therefore, even though a LRP project was designed, its actual implementation can be very slow for a given area.

Figure 16 shows a third pattern for tsunami restoration, which is being introduced to the alluvial flats area of Miyagi Prefecture. In this case, the damaged community decided to move from the seashore and build new villages adjacent to an existing community that the tsunami had affected, but not destroyed. To ensure the future safety of the community, the municipality decided to develop a multiple defense system including a canal, sand dunes, seashore forest, shrine forest, and an agricultural village forest. By undertaking an extensive survey, they came to understand that these assets, passed on from previous generations in the area, effectively weakened the impact of a tsunami.

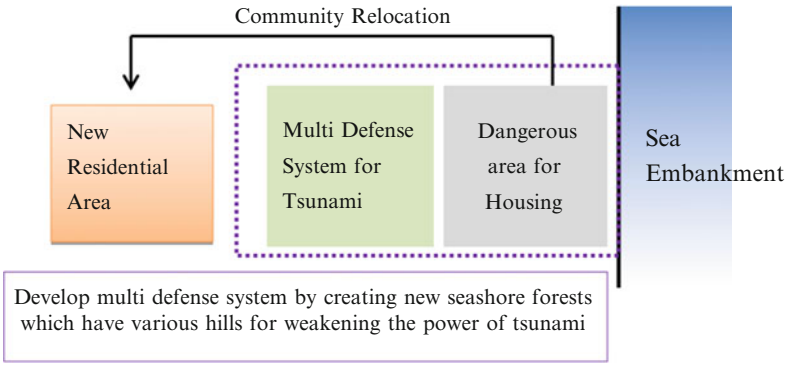

Fig. 16 Community Removal Project involving the development of a multiple defense systems for tsunami

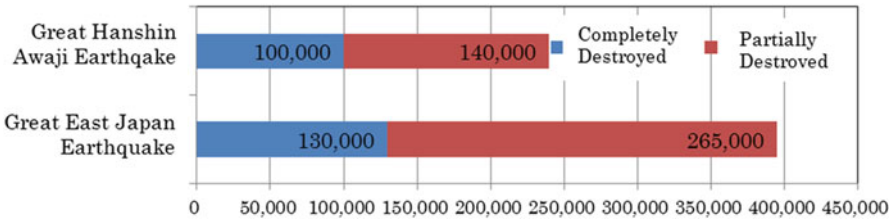

Fig. 17 Number of buildings destroyed

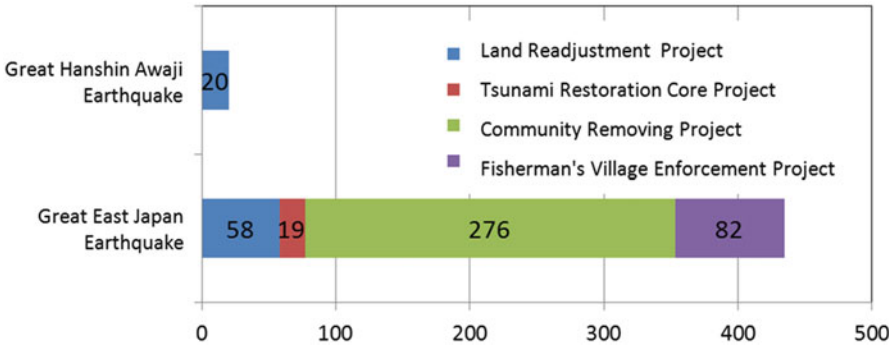

Fig. 18 Restoration project numbers

2.3 Restoration Issues

By March 2012, 43 cities, towns and villages affected by the Great East Japan Earthquake had completed restoration plans. Figure 17 shows the number of destroyed buildings and Fig. 18 shows the number of CRP and LRP, in comparison with the Great Hanshin-Awaji Earthquake of 1996.

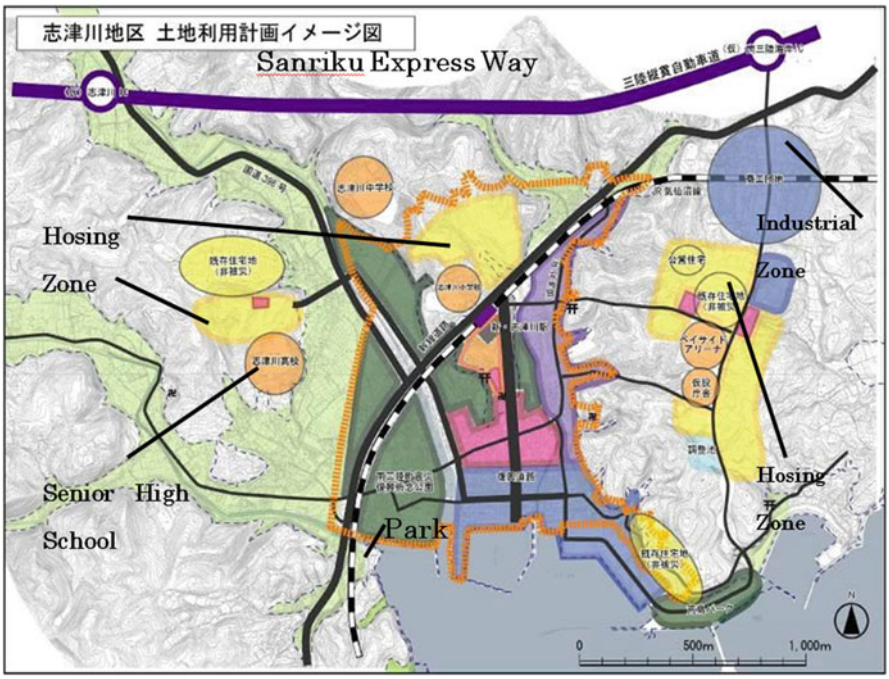

Fig. 19 Land Use Plan of Restoration in Minami-sanriku Town (*Source*: The Restoration Plan of Minami-sanriku, Sept. (2011))

The number of buildings completely destroyed by the Great Hanshin-Awaji Earthquake was approximately 100,000, compared with 130,000 in the Great East Japan Earthquake. Although the numbers of destroyed buildings are not all that different, the number of restoration projects is significantly different (Fig. 18). Because the Great Hanshin-Awaji Earthquake occurred in a dense urban area, the LRP was focused in 20 areas. In contrast, a total of 435 projects have been established for the Great East Japan Earthquake, namely 58 LRPs, 19 Tsunami Restoration Core Projects, 276 CRP, and 82 Fishing Village Enforcement Projects.

These numbers indicate the fundamental problems that underlie restoration projects associated with the Great East Japan Earthquake. The issues concern the nature of future communities that are currently being affected by a rapid decrease in population and an increase in the number of elderly people.

To examine the above situation in detail, the restoration plan being implemented in Minamisanriku provides an appropriate example. Minamisanriku, locate in the northern part of Miyagi Prefecture is a typical town in the rias coastal area. According to the restoration plan that was established in September 2011, the population will decrease from 15,655 in July 2011, to 13,000–14,500 by 2020. The municipality has a good understanding of its vulnerability.

The proposed restoration plan actually has substantial elements of enlargement, as shown in Fig. 19. Just behind the existing town, there are three steep hills. The municipality has decided to modify these hills and develop them into urban areas

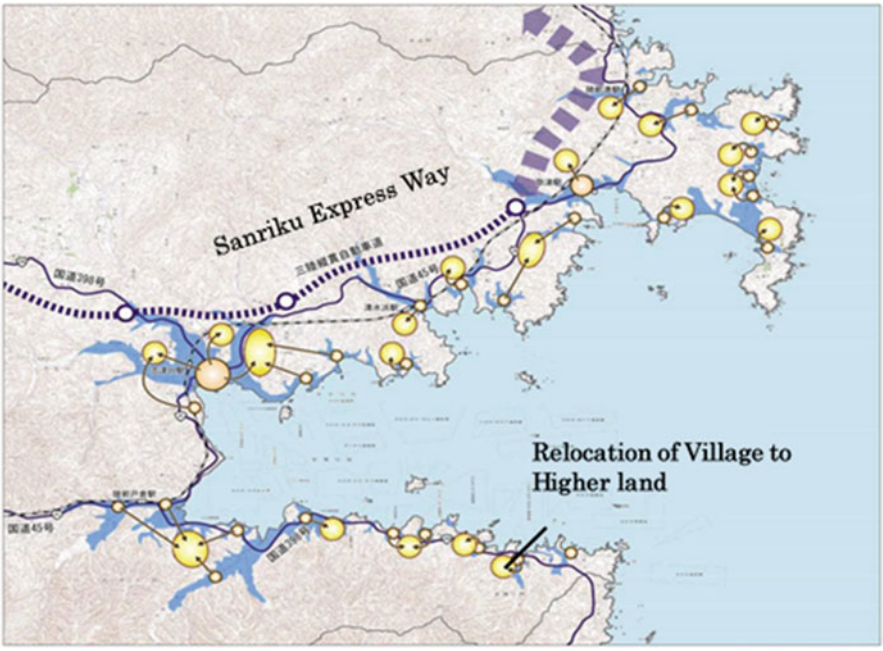

Fig. 20 Relocation Plan of 28 Villages in Minami-sanriku Town (*Source*: The Restoration Plan of Minami-sanriku, Sept. (2011))

connected by a proposed major highway. However, walking between the three new areas, will be difficult because of the steep valleys that separate them. The seashore area below would host commercial, industrial and extensive park areas, but there is concern around uptake of these facilities because residential areas will not be nearby.

Also in Minami-sanriku there are 28 small fishing villages, which are all scheduled to move up the adjacent hills (Fig. 20). Because of the rapid decrease in the population of these tiny villages, and considering the sustainability of such communities, the restoration plan may need to be revised.

It is becoming clear that the most important issue for restoration projects from the Great East Japan Earthquake is the sustainability of communities. In the following section, the concept of sustainability is examined, and methods of restoration are assessed for such vulnerable situations.

3 Restoration Methodologies for Resilient Communities

3.1 Community Sustainability

Generally speaking, the concept of sustainability contains three axes: “environmental sustainability”, “social sustainability” and “cultural sustainability”.

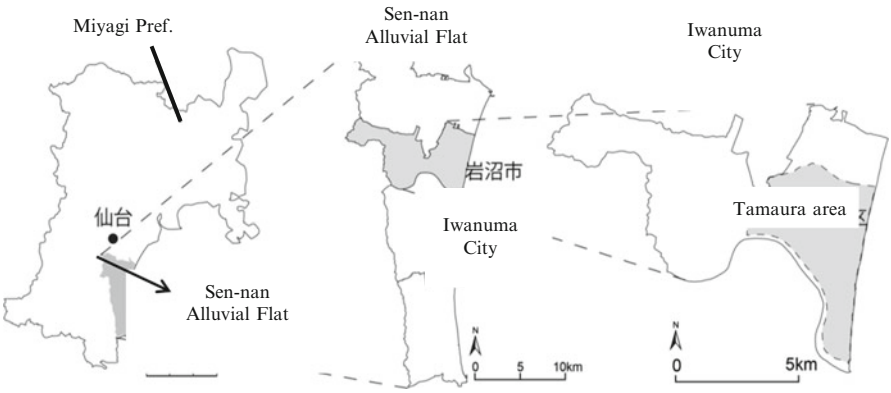

Fig. 21 Location of Iwanuma (*Source*: Baba et al. (2012))

The issue of environmental sustainability, in the case of post-tsunami restoration, is where and how to find a safe, permanent location for a community. For social sustainability, the restoration decision making process is important. The axis of cultural sustainability is very difficult to characterize because it is closely connected with the spiritual background of the people affected and history of each town and village.

To put the above community sustainability issues in context, a restoration example is presented from the small city of Iwanuma in Miyagi Prefecture, located in the Sen-nan alluvial flats of the Abukuma River.

3.2 Iwanuma Restoration Plan, Sen-nan Alluvial Flats, Miyagi Prefecture

Figure 21 shows the location of Iwanuma and Fig. 22 shows land use in this region and how this was changed by the tsunami. The geological characteristics of this region are dominated by Abukuma Mountain and the series of gentle hills running 210 km from the Pacific Ocean. The main roads from Edo, former name of Tokyo, the Oshu kaido and Rikuzen-hama kanido, were developed over time along the foot of these coastal hills. Many historic towns are located along these roads. Between the hills and the ocean, alluvial flats have formed over the past 10,000,000 years flooding of the Abukuma River.

The city of Iwanuma developed at the cross roads of Oshu kaido and Rikuzen-hama kaido, the old shrine Takekoma-jinja is a symbol of the city. Its population of 44,000 is spread over 60 km^2. Six villages on the edge of the city were located along the coast and were completely destroyed by the tsunami. 182 people died and 5,426 buildings were destroyed. In contrast with the rias coastal area, the tsunami here overran extensive paddy fields, eventually leading to salt damage. In addition, ground levels subsided below sea level during the earthquake, and therefore the basic drainage system has been completely destroyed.

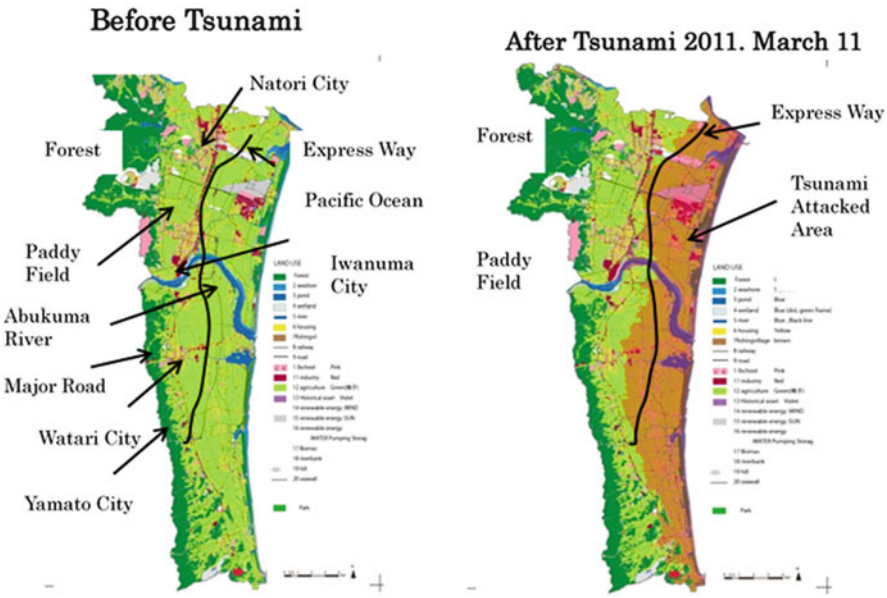

Fig. 22 Characteristic land use in the Sen-nan region before and after the tsunami

The first step for restoration in this area was to find safe refuge for the survivors. The six affected communities decided that they would not to return their villages on the seashore which had been maintained for 400 years. However, they wanted to maintain the strong ties to their former homes. This vision was declared in April 2011, very early in the restoration process. Based on this declaration, the city of Iwanuma established a restoration committee on 25 April 2011, consisting of refugees, scholars, agricultural and industrial leaders, younger residents, and the mayor. This committee established seven goals and initiated an implementation process to accomplish them. The seven goals are:

1. To set up temporary houses as soon as possible for the refugees
2. To create a safe city and find a suitable location for the re-establishment of the six villages
3. To revitalize agriculture as a first priority
4. To create new employment, utilizing the advantages of the city's airport
5. To promote natural energy projects
6. To develop a system of multiple lines of defense from a tsunami by creating 'A Hill of a Thousand Hopes' along the seashore
7. To revitalize the cultural landscape as the identity of the city

Intensive research and discussion was carried out, and on 7 August 2011, the grand design for the restoration was established. At that time, no fundamental policies or budgets had been issued from the national government. However, this committee regarded that the ideal goal of the future city should be established in the

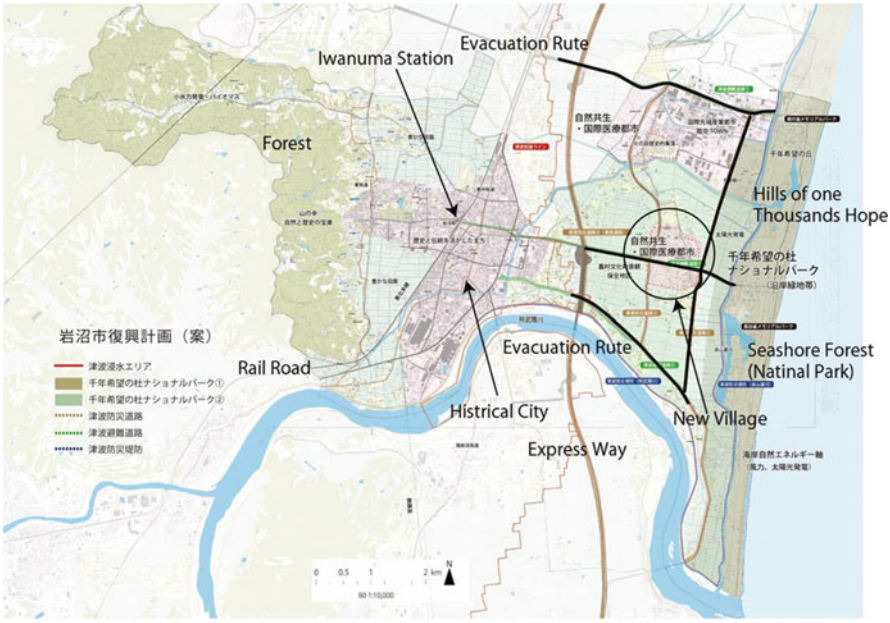

Fig. 23 Grand design of tsunami restoration in Iwanuma

beginning of the restoration. Otherwise, it would be impossible to find appropriate places for the refugees. Figure 23 shows the grand design of Iwanuma.

The main characteristic of this grand design is that the committee established an overall image for the whole city rather than considering the damaged areas only. There were three distinct historical towns in the vicinity of Iwanuma up until the 1960s, namely, Sengan in the hills, Iwanuma itself along the major road, and Tamura at the coast. The most important concern of the refugees was to keep the identity of their original community. From this aspect, the preservation of Tamura Elementary and Junior High schools was the first priority. If a new community was built outside of Tamura, the symbolic, mental, and emotional background of the community would be lost.

Based on this background, the restoration committee decided to search for appropriate safe places for the new community within the Tamura School Zone, even though there is a possibility that a tsunami would strike again.

3.3 Environmental Sustainability Ecological Infra-Structure as a Basis for Restoration

The identification of safe areas in the alluvial flats of Tamura is a difficult issue for the committee. The process required academic support, and fortunately

Fig. 24 Shinmei shrine survived the tsunami

The University of Tokyo carried out an extensive study that should support efforts to solve this problem. As the first step, we precisely surveyed how the tsunami impacted each area, and uncovered some very interesting facts. For example, many small shrines are found in each community, and most of these shrines predate past tsunami (Figs. 24 and 25). We also carried out a regional survey in the Sen-nan alluvial flats, and a lot of similar examples were identified.

Generally, these tiny shrines are located at the top of beach ridges as a symbol of the community. The difference in height is only 1.5–2 m from the near-by paddy fields, but they can have a significant effect against tsunami. According to a survey conducted by the Ministry of Land Use and Transportation, if the inundation depth of a tsunami exceeds 2 m, most houses will be completely destroyed. However, if the depth is <2 m, the possibility of destruction reduces drastically. Considering these results, examinations of micro geography are considered to be key to creating a safe city.

Figure 26 is a geological map of Sen-nan alluvial flats. From the foot of the mountain to the Pacific Ocean, three rows of beach ridges are observed, created by the flooding of the Abukuma River. The youngest beach ridge marks the present shoreline. Historically, most of villages in this region developed above these beach ridges, whereas the paddy fields developed on back wetlands. The differences in soil type turn out to be an important factor for agriculture. Considering the above basic survey information, we have combined the micro geography and soil maps to create a "Landscape Unit" (LU) map that characterizes the potential of the land (Figs. 27, 28, and 29).

Fig. 25 Sakaino-Myojin survived the tsunami

Fifteen types of Landscape Units (LUs) were classified. We undertook further analysis to investigate the meaning of specific LU, by calculating the strength of the relationship between particular land uses and an LU. Figure 30 shows the historical succession of village locations in 1910, 1931, 1977, and 2001. It is clear that a close relationship exists between the locations of villages and the LU. Most of villages are located on LU type: Beach Ridge—Gray Soil and LU type: Natural Levee—Brown Low Soil. This means that historical land use in the city has been continuous up till now, which is one reason why the tsunami damage was relatively small, compared with elsewhere in the city where rapid urbanization had taken place.

Figure 31 shows the inundation depth of the tsunami. Even in places where the distance from the shore was the same, the depth of the tsunami differed because of the type of LU. Figure 32 shows the distribution of submerging wetland after the tsunami, and it correlates well with LU: Flood Plain, Black Peat Soil.

By overlaying figures of LUs and tsunami damage, the following is observed.

1. Along the coastline, all villages were destroyed. However, in regions within about 2 km of the shore, the inundation depth of the tsunami differs because of the LUs, which have a significant effect on the damage. For example, when the depth of the tsunami was over 2 m, most houses were destroyed. However, because of micro geography, if the depth was below 2 m, the portion of houses destroyed decreased drastically.
2. Subsided land was typically observed to occur in LU, Flood Plain, Black Peat Soil.

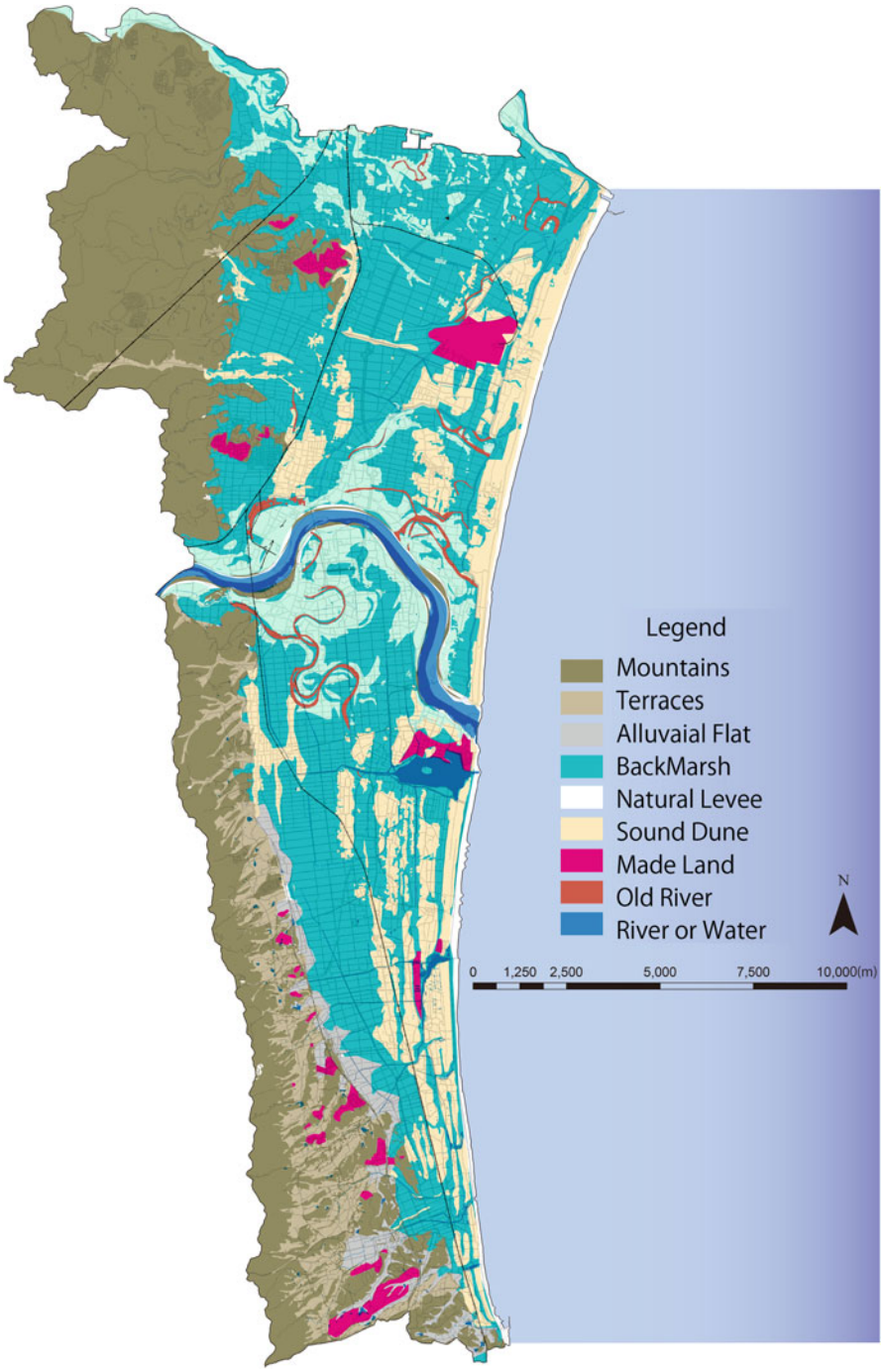

Fig. 26 Geological map of the Sen-nan Alluvial Flats

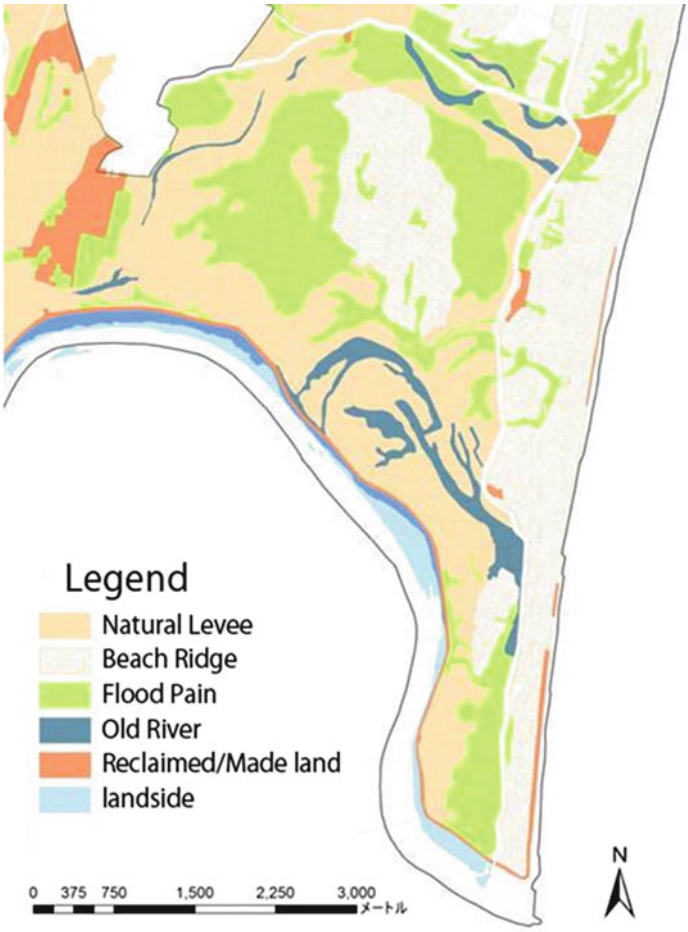

Fig. 27 Micro geography of Tama-ura

Based on these analyses, the committee selected a new location for the village on a beach ridge, more than 2 km from the shore. The area of LU: Flood Plain—Black Peat Soil was designated as a region that should be preserved as wet land, or recovered as paddy fields by totally rebuilding the drainage system.

3.4 Social Sustainability—Collaborative Decision-Making in a Restoration Process

Figure 33 shows the locations and populations of the six coastal villages and the new settlement areas. Ainokama, Ninokura and Hasegama have been fishing

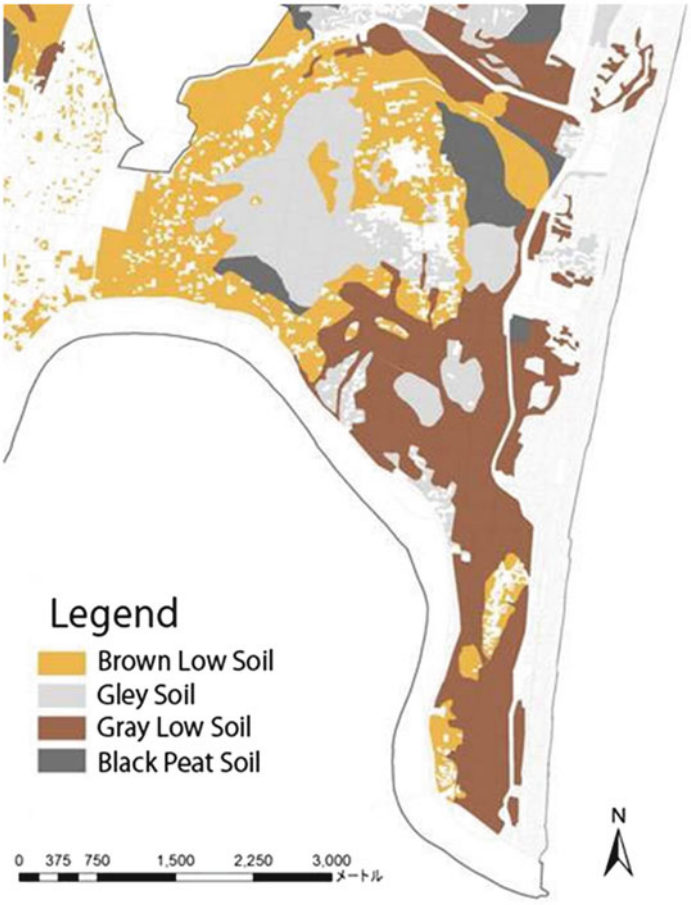

Fig. 28 Soil map of Tama-ura

villages since the Edo Era. Community bonds are very strong, and the leaders of each village undertook important decision-making roles, even though they were displaced into temporary houses that made it very difficult to assess the future of their community. The process was not as clear-cut in other regions. For example, the leader of Fujisone, a small community famous for the Kobodaishi shrine, decided to move his community. However, only seven refugees decided to join in the new settlement. The mostly agricultural community of Kabasaki is another example. Because of the position of the Teizan Canal between the Pacific Ocean and this village, the power of tsunami was weakened and several houses survived. Much debate occurred regarding whether the village should be moved. Ultimately, about 80 % of the residents decided to move and it was decided that the remaining locals could remain in the old village for their generation only. Shinhama, a river port village on

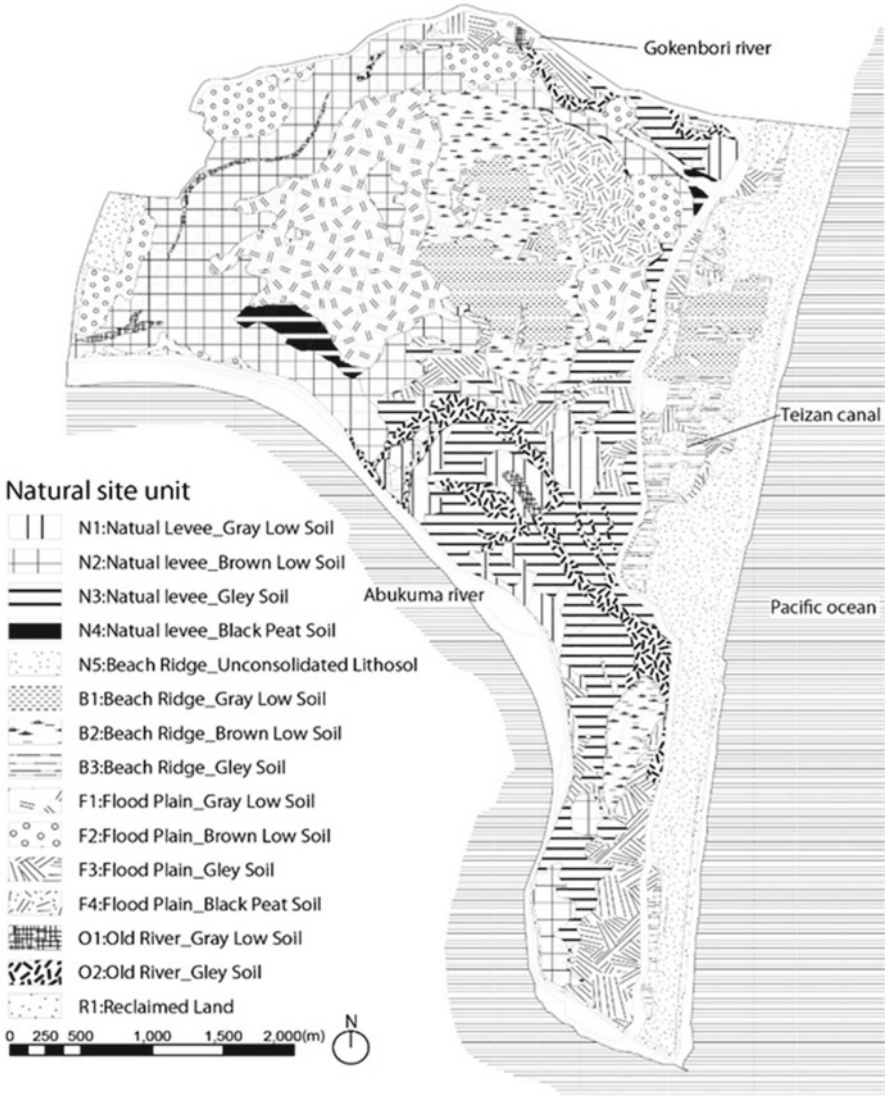

Fig. 29 Landscape Unit in Tama-ura (*Source*: Baba et al. (2012))

the Abukuma River, also had a split decision regarding moving. Historically, the community has suffered from floods, and a huge river bank had been constructed just behind the village. Therefore, some tsunami survivors insisted on remaining in the same place where they had survived the tsunami. In Shinhama, 60 % of the refugees decided to move.

In total, 1,500 people, encompassing 268 households from the six villages, and 150 households from other parts of the Tama-ura area are involved in the relocation.

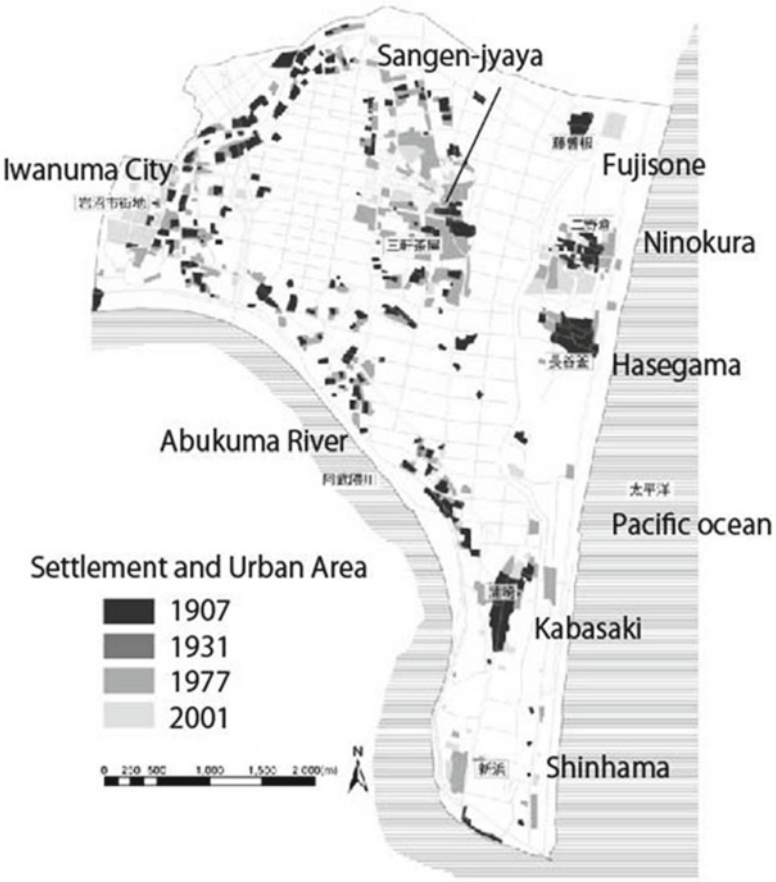

Fig. 30 Historical succession of the location of villages (*Source*: Section of Crisis Measures, General Affairs Department, Miyagi Prefecture (2012))

Figure 34 shows a vision of how Tama-ura will look in the near future. The relocated settlement is planned adjacent to the existing community. An ecological compact city is targeted, to consist of the existing community integrated with relocated settlements.

Table 2 summarizes the 2 years of restoration planning since April 2011, which can be divided into four stages. The first stage includes emergency action undertaken from 11 March until April 2011. In the case of the Great East Japan Earthquake, immediate actions are characterized by so-called "paring support". Paring support is a kind of horizontal support for damaged municipalities from specific municipalities or non-profit organizations. This system was introduced to great effect during the Great Sichuan Earthquake of 12 May 2008. Because the damaged area was extensive, the Chinese government decided to pair specific unaffected cities in support roles with each damaged city. This was a great help for the damaged areas, and

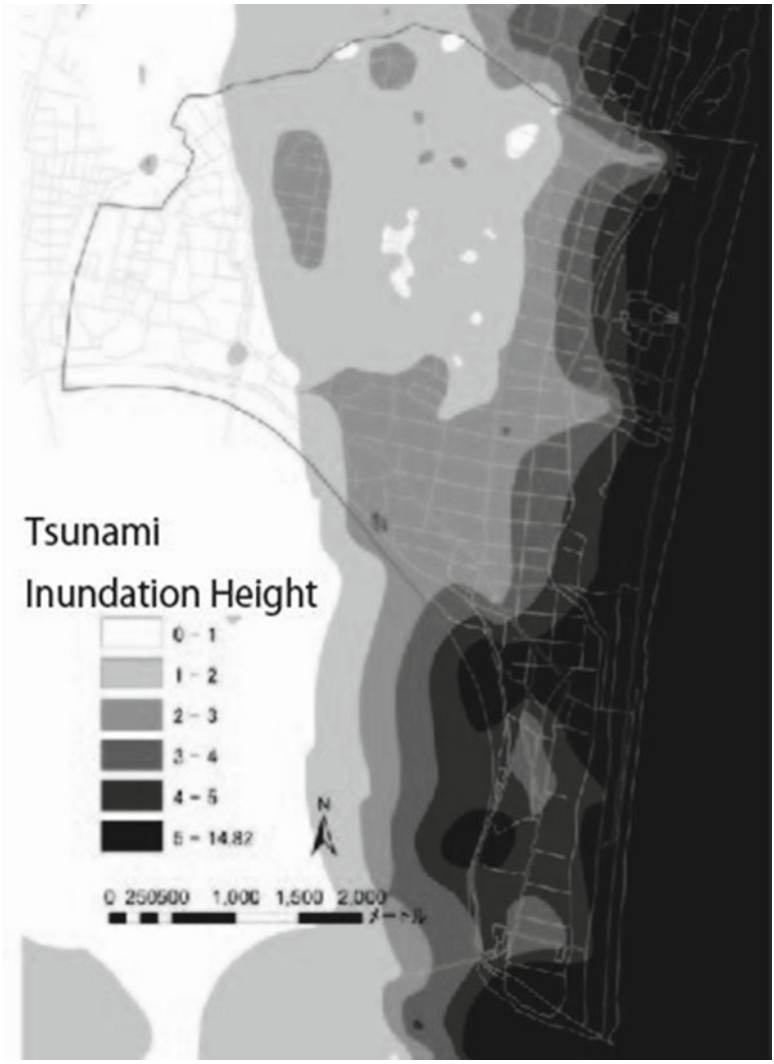

Fig. 31 Depth of the tsunami (*Source*: Section of Crisis Measures, General Affairs Department, Miyagi Prefecture (2012))

resulted in intensive, speedy restoration that was accomplished within 3 years. In the case of the Great East Japan Earthquake, the motivation for pairing was different. Rather than compulsory action from the national government, a voluntary movement developed. Numerous paring support partnerships occurred and have continued to the present.

The second stage was a period of grand design from April to August 2011. In Iwanuma as mentioned above, the ambition was to establish ideal goals for

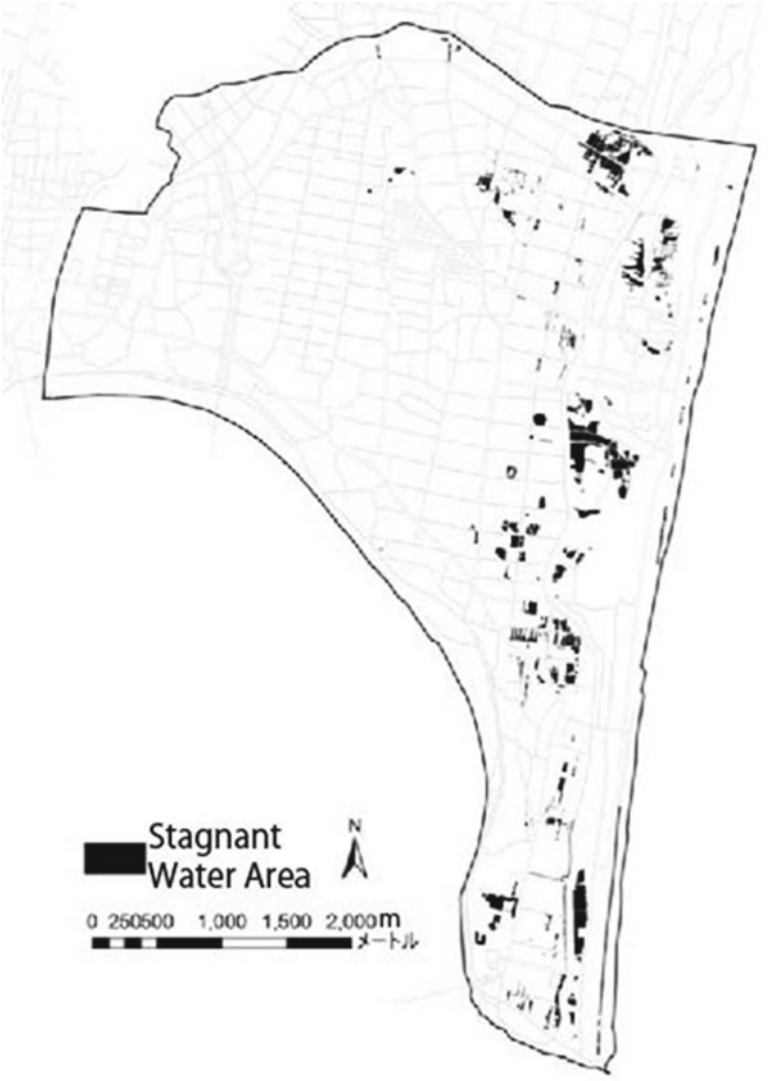

Fig. 32 Area map of stagnant water (*Source*: Section of Crisis Measures, General Affairs Department, Miyagi Prefecture (2012))

rebuilding the city at the very beginning of the restoration. Once this grand design was in place, difficulties in decision making could be dealt with by returning to the essential principals and guidelines for the restoration.

The third stage is the process of citizen participation and involvement. From September 2011 to July 2012, 10 workshops were held to develop an image of how the future city should look. During this period, no actions from the national

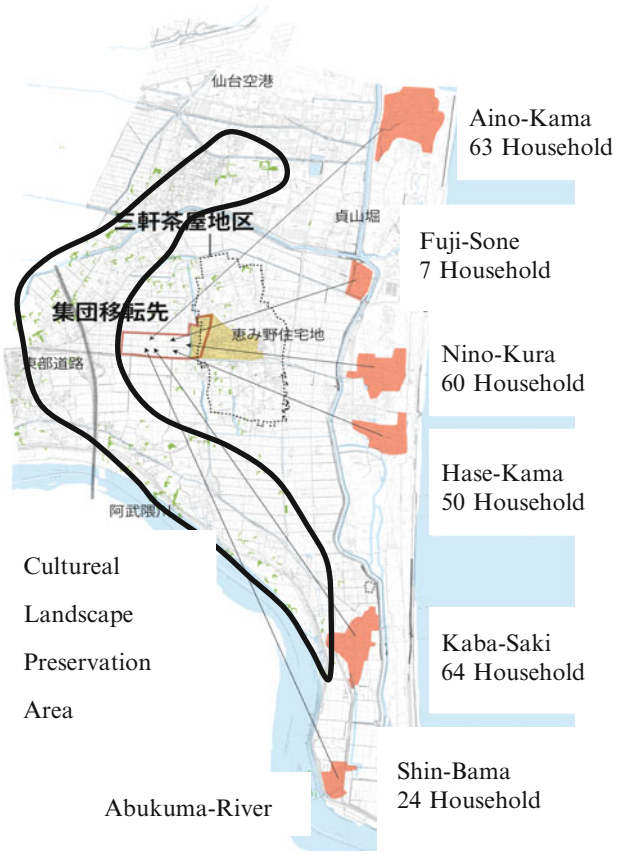

Fig. 33 Location of six villages and the removal area to where will be moved

government were implemented, nor were any budgetary restraints imposed. However, the development of plans from the perspective of those who had lived through the disaster made an important contribution to the overall success of planning. Figure 35 shows a scene from one of these workshops. The exercises were a great learning experience for everybody involved.

The fourth stage is the formal Machizukuri (city planning with citizen participation) period. This has been conducted by Iwanuma on an ongoing basis since June 2012. In March 2012, the plan of CRP had officially approved from the ministry of Restoration, and the budget was decided. Based on this legal structure, the Machizukuri Committee organized as a formal decision making committee in June 2012. Representatives from the six affected villages and the neighboring areas were elected to key roles to implement the vision of restoration established earlier.

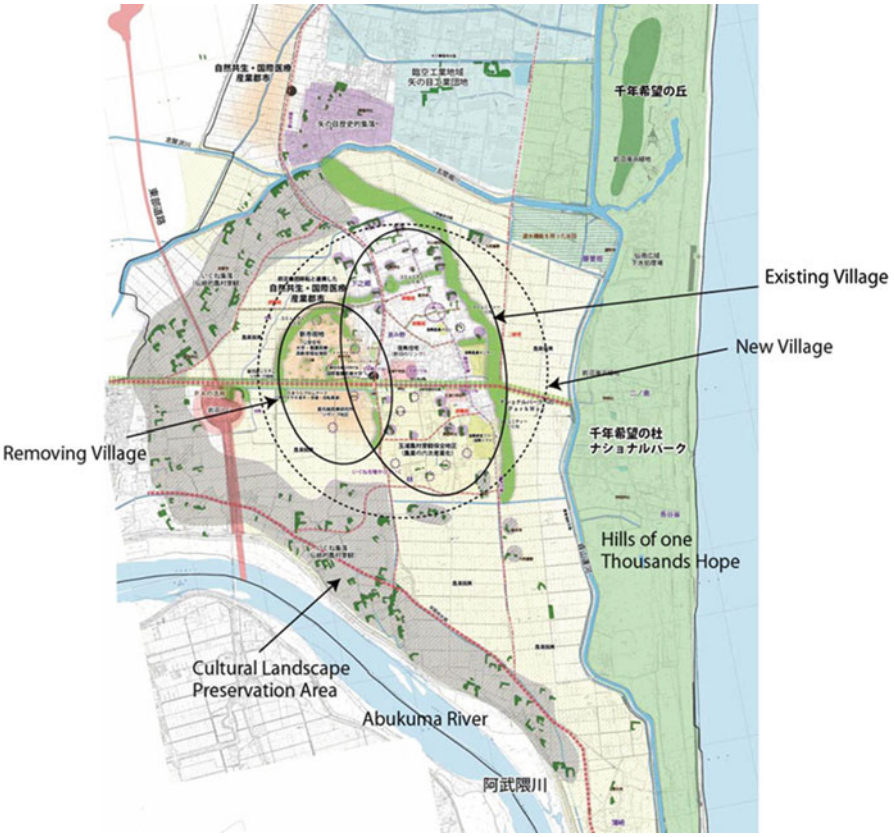

Fig. 34 The image of Ecological Compact City

3.5 Restoration of a Cultural Landscape as a Basis for Cultural Sustainability

Finally, we investigated the issue of cultural sustainability. Because the tsunami wiped out almost everything in the region, it is very difficult to identify cultural assets here. Festivals, traditional music, and human relations are, of course, the most important cultural assets. However, to rebuild actual sites, it was essential to extract the hidden order that this region had developed over the centuries as man struggled with nature to develop a society.

An extensive survey was undertaken over the Sen-nan alluvial flats that identified the almost organic formation of agricultural villages as a characteristic cultural landscape in this region. Figure 36 is a map of the agricultural village in the vicinity of Tama-ura dating from roughly the seventeenth century. In this picture, the upper river is the Natori River. Farm houses were essentially located on natural levees

Table 2 Planning process of Restoration

Date	National Gov.and Miyagi Pref.	Date	Iwanuma	
Date	National Gov.and Miyagi Pref.	Date	Stage	Iwanuma
2011				
3.11	Great East Japan Earthquake	3.11		Great East Japan Earthquake
3.17	Emergency Actions; Water, Food, Medical Support	3.12~		Pairing Support start
		4.25	Grand Design	Iwanuma Restoration Committee No. 1
5.2	First Law for the budget for East Japan Earthquake established	5.1		The Promoting Office of Restoration opened
	First budget (4,015,300,000,000 ¥)	5.29		Iwanuma Restoration Committee No. 2
6.24	Fundamental Law of the Restoration			
	Principals, Responsibility of National Government and Municipality, Budget, Special District	6.3		All Refugees moved to the Temporary House.
7.25	Second Budget (1,910,600,000,000 ¥)	7.3		Iwanuma Restoration Committee No. 3
	Fundamental policy for the compensation to the damage by the nuclear accident			
7.29	Fundamental Strategy of the Restoration			
8.5	Special Law for the Refugees from the Nuclear Accident	8.7		Grand Design of the Restoration, established
8.17	Restoration Plan of Miyagi Pref. (Final Version)		Master Plan	
		9.1		Master Plan of the Restoration established
10.19	Restoration Plan of Miyagi Pref. established	10.25	Citizen workshops	Iwanuma City designated as Environmental
		11.12		Citizen Workshop No. 1
11.21	Third Budget (9,243,800,000,000 ¥)	11.21		
11.30	Law of the Budget for Restoration			
12.7	Special District for Restoration	12.3		Citizen Workshop No. 2
12.9	Law for Ministry of Restoration	12.4		Citizen Workshop No. 3
		1.22		Citizen Workshop No. 4
		2.17		The committee of Restoration of Iwanuma No. 1
		2.19		Citizen Workshop No. 5

2012				
2.10	Establishment of Min. of Restoration			
		3.23	Community Removal Project	Committee of Restoration of Iwanuma No. 2
3.28	Vision of Miyagi	3.27		Development Plan of Restoration
3.30	Special Law for the Restoration of Fukushima			
4.5	The budget in 2012 for Restoration (3,775,400,000,000 ¥)	5.19		Workshop No. 6
		5.22		Committee of Restoration of Iwanuma No. 3
		6.03		Workshop No. 7
6.21	Law for Supporting Children suffered from Tsunami	6.11	Machizukuri Committee	Machizukuri Committee in Tama-ura
		6.17		Workshop No. 8
7.13	Fundamental Strategy for Fukushima	7.8		Workshop No. 9
		7.21		Workshop No.10
		8.6		Construction of CRP in Tama-ura begun
9.20	Evaluation of Future Miyagi	9.24		Land use plan in CRP established
2013				
		2.06		Fundamental Plan for Parks Open Spaces in CRP

Fig. 35 Workshop for a new relocated community

(Landscape Units N1 and N2). Since the formation of the LU was so irregular, as a result of historical accumulation from many floods, the form of agricultural communities had developed as a response to this hidden order. Roughly 10 to 20 farm houses were grouped together as a unit and combinations of these units created a village. Surrounding each unit, an agricultural forest, called an "Igune", lessened the impact of north-west winds in winter and coastal winds from east. The characteristic village landscape that developed on the natural background in this way can now be considered a "cultural landscape".

More than 200 Igune existed in Tama-ura prior to the tsunami. Igune can be divided into three types: independent Igune, continuous community Igune and neighboring Igune (coinciding with 3 or 4 houses). Figures 37 and 38 show the largest independent Igune in Tama-ura. Figure 37 was taken in Sept. 2011 and Fig. 38 in April 2012. As can be seen, the Igune that suffered from salt damage had completely died. The function of Igune and the way in which they behaved during the tsunami was investigated by sending questionnaires to survivors. The following conclusions can be drawn.

An Igune is a kind of agricultural forest, of which we could find many similar examples in the regions affected by the Asian monsoon. Their role is not only to prevent winds, but also to produce timber, fruit, flowers and vegetables. Their existence also acts like a barrier to protect the nearby farmhouses. An Igune can be regarded as a mental or cultural forest for the local residents. We surveyed the Igune in August and September 2011, just before completely died. Figure 39 shows a typical Igune in Tamura. The main tree species in the Igune is *Cryptomeria japonica*, which has proven useful for repairing and building houses. Under the canopy, evergreen trees such as *Camellia japonica* and *Enonymus japonica* have developed.

Fig. 36 Agricultural village in Yanagiu, Natori in the Sen-nan alluvial flats (*Source*: History of Sendai, Feudal Era No. 3)

There are also many flowering trees and fruit trees such as *Prunus mume*, *Prunus armeniaca*, and *Citrus junos*, in addition to the symbolic landscape tree, *Zelcova serrate*.

When the tsunami struck, the Igune became very important in preserving houses from destruction and in saving human lives (Figs. 40 and 41). During the citizens' workshops, it gradually became obvious just how important the Igune were in the day-to-day life of the local population. Because the Igune had always been present as a backdrop to civilization in the area, the local residents had not been fully aware

Fig. 37 Igune in September 2011

Fig. 38 Igune in April 2012

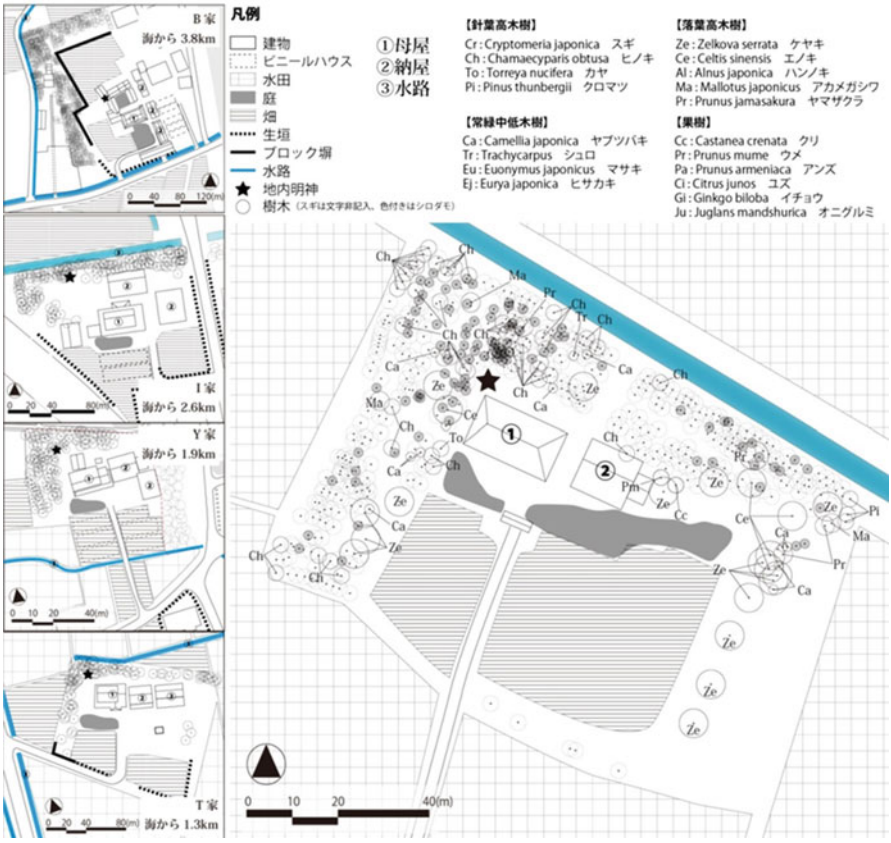

Fig. 39 Formation and species of Igune in Tamura

of their meaning and significance. However, through the discussion process at workshop, the revitalization of the Igune became a major goal of the restoration. By October 2012, the collection of acorns from Satoyama, Iwanuma, was begun to initiate a tree nursery in temporary houses (Figs. 42 and 43).

4 Conclusions

In this chapter, attempt has been made to investigate the characteristics of the tsunami, considering the variable geological structures of the different regions affected. A consideration of the social setting is also required considering the decreasing population coupled with an increasing vulnerable elderly population. In most cities and towns, restoration plans have already been established, but the realities of

Fig. 40 Igune prevented the destruction of a farm house, May 2011

Fig. 41 Igune prevented the destruction of a farm house, May 2011

Fig. 42 Collecting acorns from Satoyama

Fig. 43 Making a nursery at a temporary site in Tamura

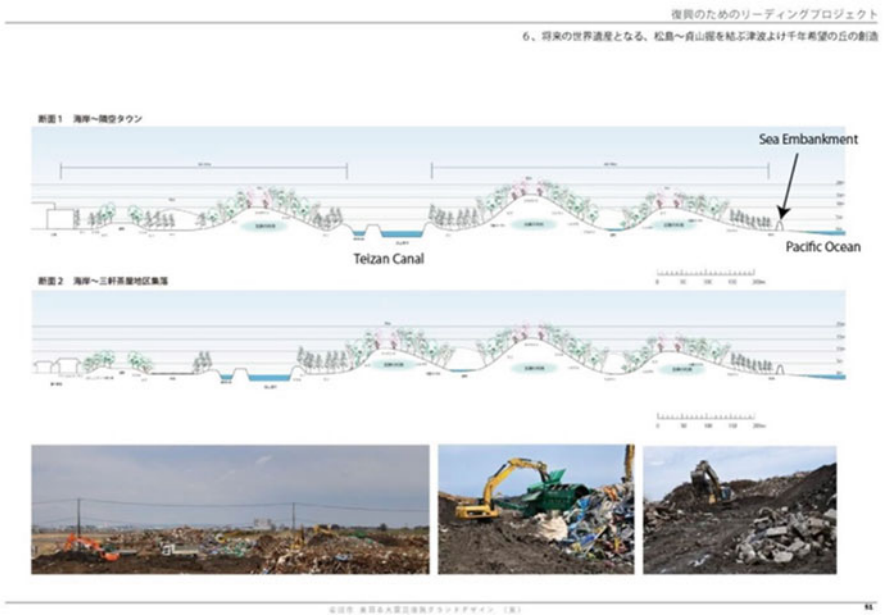

Fig. 44 Hill of A Thousand Hopes (*Source*: Committee of restoration in Iwanama, The grand design of the restoration (Iwanama, August 7, (2011))

implementation will require a strict adherence to these plans for them to succeed. A total of 456 restoration projects are currently known, a huge number when compared with 20 that were established in Kobe. The most essential issue for the aftermath of the East Japan Earthquake is community restoration.

From the above analysis, a hypothesis has been established for creating resilient communities from the viewpoint of environmental, social, and cultural sustainability. The case study of Iwanuma, Miyagi Prefecture shows how this is being implemented. Based on documentation of the actual processes followed from March 2011 to the present, the above three aspects of sustainability have been used to develop a method for restoration. For environmental sustainability, the concept of Landscape Units can be used to establish new land use in alluvial flat areas of the coastal plain. For social sustainability, it is important to set up a grand design, and to undertake the restoration as collaborative works with the tsunami survivors in the region. Finally, the development of a cultural landscape is an essential goal of the restoration. The cultural landscape is not only a work of preservation, but should also be a creative process. Figure 44 shows new forest along the coastal zone, named the "Hill of a Thousand Hopes". This is a set of gentle hills made of materials destroyed by the tsunami, and it will be planted with many species identified by academic research. The idea was advanced by the analysis of micro geography to reduce the power of future tsunami. Also, Fig. 45 shows the watershed in Iwate and Miyagi Prefectures. The cultural assets here are closely related to the formation of the watershed where each community exists. Further analysis of the tsunami restoration methodology will and should continue through the long process of restoration.

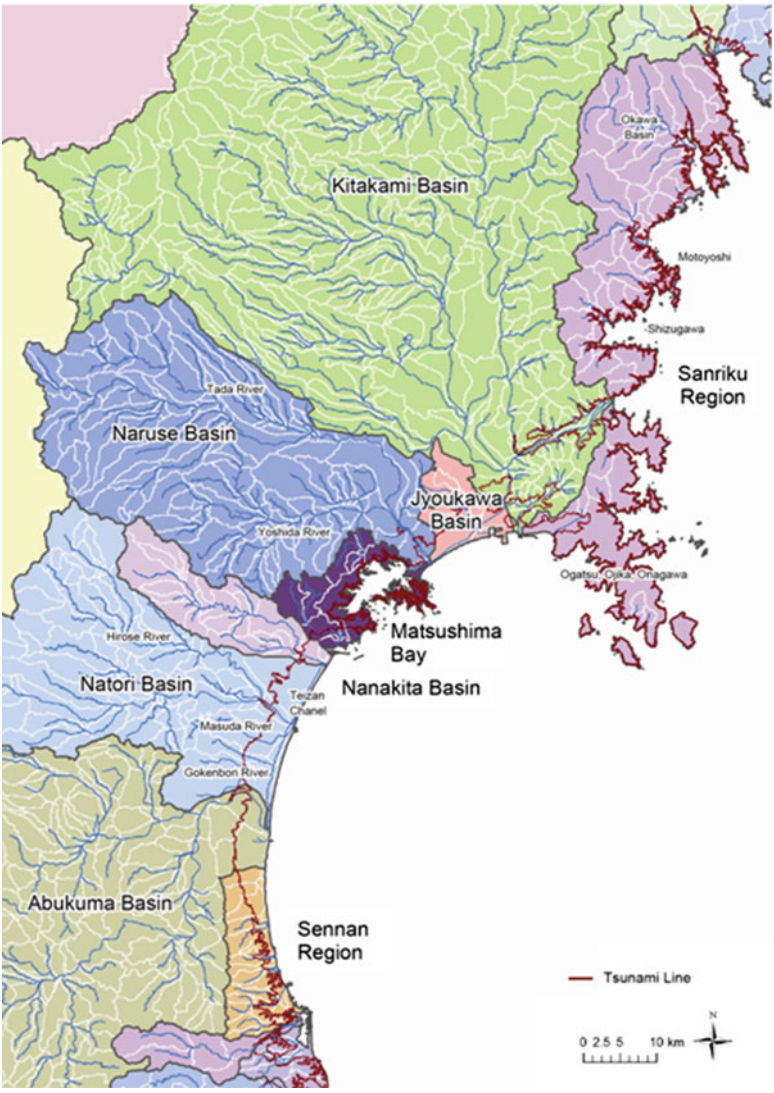

Fig. 45 Watersheds in Iwate, and Miyagi Pref

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About the Editors

Dr. Kohei Okamoto is a professor, Geography Department, Graduate School of Environmental Studies, Nagoya University, and the Chair of the Scientific Program and Publication Committee for the International Geographical Union Kyoto Regional Conference. He is the author of *Cognition and Behavior in Urban Space* (2000) and editor of several books, including *The Handicapped and the City: Geographical and Psychological Approaches* (2006), *Activity Spaces in Urban China* (2008). His research interests are behavioral geography and time geography.

Dr. Yoshitaka Ishikawa is a professor, Geography Department, Graduate School of Letters, Kyoto University, and was the Chair of the Organizing Committee for the International Geographical Union Kyoto Regional Conference. He is the author of *Quantitative Geography of Migration* (1994) and editor of several books, including *Migration in Asia/Pacific* (2005) and *Population Decline and Regional Imbalance: Geographical Perspectives* (2007). His research interests are population and migration in developed countries and, in recent years, ethnic geography, particularly in Japan.

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About the Authors

Dr. Minoru Senda is the director of the Nara Prefectural Library and Information Center and a professor emeritus at the International Research Center for Japanese Studies. He has published many exciting and absorbing books from the perspective of historical geography encompassing traditional wisdom, such as *Archaeology of Landscape* (1996), *A Warmly Civilized Country, Japan* (2011), *Cosmos of Kojiki: Kami and Nature* (2013). He also has organized several international conferences including *Urban Morphology and the History of Civilization in East Asia* (2004) and *The Transformation of Traditional Notions of Geography in East Asia and Its Environs Caused by the Introduction of the Modern Discipline of Geography* (2004–2006).

Dr. Ge Jianxiong is a professor of History at Fudan University. He was the former director of the Institute of Chinese Historical Geography and the Historical Geography Research Center of Fudan University. He is the author of many books including *Chinese Immigration History* (1997) and *China Population History* (2005). He has served the development of historical geography. He is one of authors on Japanese book entitled *What is China for Japan* (2005).

Dr. Jean-Robert Pitte is president of the French Geographical Society and former president of the University Paris-Sorbonne (Paris IV). He is the author of many books and some of them were translated into Japanese, including *Histoire du paysage français : De la préhistoire à nos jours (History of the French Landscape: From Prehistory to the Present Day)* (1983), *Paris: histoire d'une ville (Paris: The History of a City)* (1993). *Le désir du vin à la conquête du monde (The desire of wine to conquest the world)* (2009). His research interest has been on the history of landscape and the study of gastronomy. He chairs the Wine Academy of France.

Dr. Kazunobu Ikeya is a professor of National Museum of Ethnology, Japan. He is the author of many publications on cultural geography and environmental anthropology, for example, *Updating the San: Image and Reality of an African People in the twenty-first Century* (2006) and *Interactions between Hunter-Gatherers and Farmers: From Prehistory to Present* (2009). His recent research project is "The Studies of Livestock Breeding among the Farmers in Asia and Africa".

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Dr. Sarah A. Radcliffe is a professor of Latin American Geography at University of Cambridge. She is the author of many books including *Indigenous Development in the Andes: Culture, Power, and Transnationalism* (2009) and *Culture and Development in a Globalizing World: Geographies, Actors and Paradigms* (2006). Her research interests include development and postcolonial governance, geographies of contested postcolonial national identities and political transnationalism in Andean countries.

Dr. Paul Robbins is director of the Nelson Institute for Environmental Studies at the University of Wisconsin-Madison, former professor and director of the School of Geography and Development at the University of Arizona. He is the author of many books including *Political Ecology* (2nd edition, 2012) and *Law People: How Grasses Weeds and Chemicals Make Us Who We Are* (2007). He seeks to explain human environmental practices and knowledges, the influence non-humans have on human behavior and organization, and the implications these interactions hold for ecosystem health, local community, and social justice.

Dr. Kenji Satake is a professor of Earthquake Research Institute, The University of Tokyo. His research interest is giant earthquakes and tsunamis in the world, for which he uses geophysical, geological or historical approaches. His professional carrier includes an assistant professor at University of Michigan and senior researcher at Geological Survey of Japan. He is currently the president of Asia and Oceania Geosciences Society (AOGS). He is also the author and editor of many articles and books including *Science of the Great East Japan Earthquake* (2012) and *Historical and Recent Catastrophic Tsunamis in the World* (2013).

Dr. Itsuki Nakabayashi is a professor of Research Center for Crisis and Contingency Management, Meiji University and a professor emeritus of Tokyo Metropolitan University. He is engaged in regional disaster prevention managements from the viewpoints of geography and urban planning. He is the many publications including *Earthquake Vulnerability Assessment and Anti-Earthquake Disaster City Planning in Tokyo* (2008) and *Disaster Management System for Wide-Area Support and Collaboration in Japan: Focused on Mega-disaster in Tokyo Metropolitan Region* (2010).

Dr. Mikiko Ishikawa is a professor of Chuo University and a professor emeritus of the University of Tokyo. She is working hard to reconstruct her hometown, Iwanuma of an affected area of the Great East Japan Earthquake. She wrote many books including *City and Green Space* (2001) and *Theory and Practice of Water Basin Environmental Management and Design* (2005), and won many awards such as *The First Prize of Public Park Design from the Ministry of Land Use and Transportation in Japan* (2010) and *The First Prize of Environmental Design from Japan Architectural Environment Institute* (2009).