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Angela Colucci
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Peri-Urban Areas and Food-Energy-Water Nexus

Sustainability and Resilience Strategies in the Age of Climate Change

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Preface

Over the last few years, the fairly new concept of the food–energy–water nexus has become one of the most interesting and promising references in the analysis and identification of environmental strategies both at global and at local levels. Among the different approaches that rely on this concept, this book considers the nexus not only as a relevant issue for environmental sustainability, but also in relation to the concepts of resilience towards environmental changes and natural disasters. In this respect, the book considers three main issues: the nexus in Peri-Urban areas; the effective management of the nexus as a means to create resilience towards environmental changes and in particular to climate change; and an effective management of the nexus in risk mitigation policies.

In fact, as for the first innovative aspect, the relationship between agricultural and urban areas has become particularly crucial in large metropolitan areas. Production of food in large urban areas has been indicated as an important opportunity to make cities more sustainable and to provide ecological services.

The development and protection of these services requires an integrated management of the major resources that characterize the metabolism of a city. Furthermore, it requires a stronger coordination between the stakeholders who weight differently the services that are relevant to them in an urban environment. Moreover, any strategy aimed at achieving both sustainability and resilience has to integrate efforts towards environmental protection, adaptation to and prevention of climate change and disaster risk mitigation. A more sustainable city is one that offers the best combination of environmentally compatible production and exploitation of energy and food and optimizes cycles of water use and reuse, leading to an overall reduction of carbon dioxide emissions. In the meantime, a better management of the nexus can significantly contribute to the adaptation to climate change. The nexus is also implied in disaster risk reduction, basically in all phases of the so-called disaster cycle, from the pre-event mitigation to recovery and reconstruction. The perception of the nexus before, during and after disasters may be different in developing countries and in rich ones, but clearly the energy

production processes and water management are core aspects of many disasters all over the world.

Considering the nexus in such a broad perspective requires a large effort of integration, first between disciplines and scientific and technical approaches and second between policies. The need to integrate approaches, methods and tools specific to different disciplines that deal with food–energy–water has been already pinpointed by researchers and scholars. However, an even larger effort has to be made in the management of the nexus in climate change adaptation and in disaster risk mitigation that until now have been considered rather separately from environmental policies in general.

An additional challenge refers to the integration of policies on the nexus that are generally conducted in a rather sectorial fashion by administrations, agencies and stakeholders who rarely consider the countereffects that their decisions have on those sectors that they do not manage directly. In this regard, the presence among the authors of this book of stakeholders pertaining to public administrations with different responsibilities at various scales is of great relevance, showing that also at the political and decision makers' level, something is moving and changing.

The book is organized into two parts. The first addresses some general issues, including the need to consider the nexus not only in ordinary times, but also in relation to adaptation policies to climate change and in the context of resilience to disaster risks.

The second part is devoted to discussing case studies and reflections regarding the nexus approach, looking in particular at the nexus through water-, food- and energy-related angles.

Four chapters deal with the nexus from a water-related perspective. Water is considered as a resource that has to be managed within qualitative and quantitative safe boundaries. As for qualitative aspects, clean water is the basis for life and everyone should have access to it. Unfortunately, this is not what happens in many developing and poor countries; however, water pollution is an issue also concerning the developed ones and requires the adoption of ad hoc policies and controls. From a quantitative perspective, that is granted more attention in the book, water scarcity, due to arid climatic conditions (that may be worsened by climate change), droughts and poor management system, is tackled in Guido Minucci's contribution. Too much water, resulting in floods, also threatens human settlements and may provoke severe damage to many sectors, including agriculture. Those aspects are developed in Patrick Pigeon's contribution. Francesco Puma, for many years general secretary of the Po River Basin Authority, describes the plans and the programmes developed and implemented in particular in response to the Water Framework Directive in an attempt to couple ecological and environmental sustainability and flood risk mitigation. They discuss the results, including successes and limits of their activity that have been carried out through European funded projects and local initiatives.

The food issue is approached as an integrated aspect of Peri-Urban areas management with regard to urban–regional metabolism. Specific emphasis is put on the interrelations of food with neighbouring fields, such as landscape, water and energy, connecting the social, economic and ecological dimensions of Peri-Urban

development. Against this background, different aspects of Peri-Urban governance are explored, including questions of multi-level (local/regional/supra-regional), multi-actor (public/private, including businesses as well as citizens) and multi-instrumental (formal/informal; processual; economic/incentives; organizational). Jörg Knieling and Elena Jachia discuss examples of urban–rural partnerships that allow integrating regional potential of food production with the urban demand and have become relevant issues at the European and international levels (OECD programmes, EU programmes and policies, etc.).

Mara Cossu and Silvia Pezzoli show that new methods and tools of evaluation of "Peri-Urban" polices aimed at reinforcing local resilience are needed.

In the last part, three contributions present good practices and results of research projects focusing on food chains integrating environmental, social and economic aspects. By illustrating good practices and innovative responses, Rolf Oldejans and Aurora Cavallo, Benedetta Di Donato, Rossella Guadagno and Davide Marino identify the complex range of services that could be provided by Peri-Urban areas in terms of ecosystem, social and leisure services. Finally, Gioia Gibelli, Luca Bisogni and Angela Colucci show the advantages of innovative practices in both economic and ecologic terms, and mutual advantages derived from an integrated approach.

The last articles, related to the "energy" perspective, mainly focus on the contributions that different areas, and especially the Peri-Urban ones, can give in meeting the energy demand of cities and on the effects on water management, agricultural production, economy, landscape and ecosystem services.

Two issues have been tackled in particular, the first one being the production of energy. Eugenio Morello discusses the criteria of use and actions required to produce renewable energy in Peri-Urban areas; Chiara Cortinovis suggests an innovative and more efficient way to develop district heating as an urban infrastructure, while Mauro Brolis presents strategies to reduce the use of fossil fuels in the Lombardy region increasing energy efficiency and the use of renewable energy sources.

The second one is focused on the connection between energy and agriculture. The concept of bioregion is defined and explained by Gianni Scudo and Matteo Clementi. They consider the bioregion as a fundamental reference to evaluate strategies aimed at increasing the eco-efficiency of an area.

Milan, Italy

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Part I
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Chapter 1
Climate Policies and Strategies in the European Union

Stefano Caserini

Abstract The European Union has an important climate strategy composed of many Directives, Commission decisions, Regulations, White Papers, etc. all of which are aimed at adapting to climate change (to manage the unavoidable) and to mitigate climate change (to avoid the unmanageable). After having largely reached the target of the Kyoto Protocol for the period 2008–2012, the EU has adopted a voluntary target for the years 2020 and 2030 (−20 and −40 % of greenhouse gas emission reduction compared to 1990, respectively) as well as a long term target of nearly complete decarbonisation of his energy system for the year 2050. The greenhouse gas emission reductions that already occurred in the EU are substantial, if accounted as a production-based approach, and the EU is a driving force in international negotiations on climate change for supporting both mitigation actions and adaptation measures.

1.1 Introduction

Climate change is happening and there is a widespread and increasing consensus that we should aim to limit the future global average temperature increase as low as possible, in order to limit the damage. The more action is postponed, the greater the risk of irreversible climate change, and options to stabilise greenhouse gas (GHG) concentrations at lower levels are closed off.

Since 1996 the EU has identified a climate policy objective of limiting the global average temperature increase to 2 °C above pre-industrial levels, a target that has been subsequently recognized and adopted during the international negotiations.

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1.2 From the Kyoto Protocol to the 20-20-20 Package

The first European climate commitment is the Kyoto Protocol (KP), ratified in 1998, which committed the EU15 to reduce their emission by 8 % below 1990 levels by the period 2008–2012. The EU largely respected this target, reducing the EU15 GHG emissions by 12 % during 2008–2012. The step decrease of the emissions during the period 2007–2012 in the EU28 emissions (Fig. 1.1) was partly due to the economic crisis, but also due to some policies that were put in place, such as the Emission Trading Directive, approved in 2003, that established the most important emission trading system (EU-ETS) in the world, with approximately 12,000 installations involved.

Another milestone in the EU Policy on climate change is the "*2008 Climate Action and Renewable Energy Package*",[1] widely known as the "*20-20-20 Package*", because the EU set three targets for the year 2020:

- to cut emissions by 20 % (or by 30 % if agreed globally);
- to increase energy efficiency by 20 % (compared to baseline);
- to generate 20 % of energy from renewable sources.

The 20-20-20 Package includes many policy actions, first of all an extension of the EU-ETS, a support for carbon capture and storage, as well as the country-specific targets for renewable energy and GHG emissions from non-ETS sector (domestic and commercial heating, traffic, agriculture, small industrial, waste, land use change).

In this framework, many actions at local level have started, such as the "Covenant of Major" (CoM), a voluntary initiative to promote awareness at the local scale of the climate and energy policies. The CoM was initially thought for big cities, then it was extended to medium and also small cities. In 2015, more than 6,300 European cities have signed the CoM (more than 1400 of them are Italian), for about 200 million inhabitants, and are committed to reduce their GHG's emissions by more than 20 %.

We have to recognize that many municipalities signed up without knowing what their signature really meant; they approved many interesting Sustainable Energy Action Plans (SEAP) but without a well-defined analysis of the feasibility of the adopted target. The constraints of the "fiscal compact" are a very serious brake in the implementation of SEAP measures, at least in Italy; so there is a risk that many signatures will not be followed by real implementations of the actions and by an effective monitoring and verification of the actions taken.

[1]European Commission (2008) The 2020 climate and energy package. http://ec.europa.eu/clima/policies/strategies/2020/index_en.htm.

Fig. 1.1 The EU-28 Greenhouse gas emissions during the period 1990–2012, excluding LULUCF (1990 = 100 %). 2020 target is also indicated. *Source* EEA, 2014, Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014. EEA Technical report No 9/2014

1.3 The 2050 Roadmap and the 2030 Climate and Energy Goals

During the last few years other important climate policies have been put in place by the EU. In 2011 three roadmaps were approved:

- a Roadmap for a low-carbon economy in 2050,[2]
- an Energy roadmap,
- a Roadmap to a Single European Transport Area.

The EU target "Roadmap for a low-carbon economy", included cutting greenhouse gas emissions by 80–95 % by 2050, will require a huge transformation of the EU energy system (Fig. 1.2). Briefly, the energy efficiency of the overall system has to increase substantially. About two thirds of the energy should come from renewable sources and electricity production needs to be almost emission-free, despite higher demand. The goals of such a transformation are not only environmental, but are also related to the security of the supply, competitiveness and

[2]European Commission (2011) Roadmap for moving to a low-carbon economy in 2050. http://ec.europa.eu/clima/policies/strategies/2050/index_en.htm.

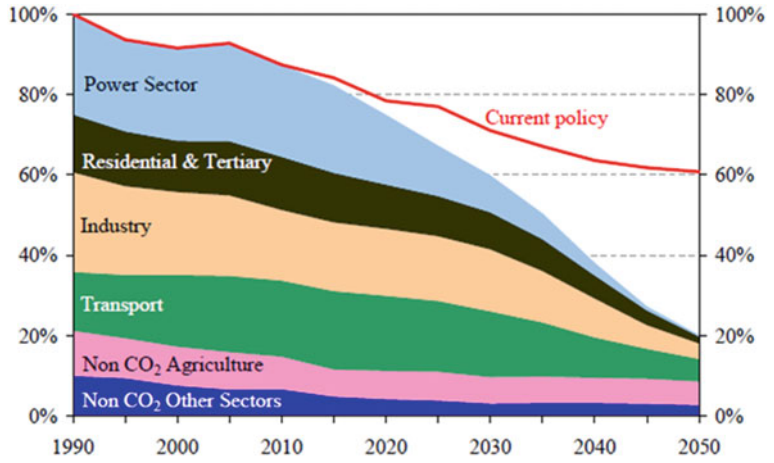

Fig. 1.2 The EU greenhouse gas emissions towards the 80 % domestic reduction (100 % = 1990) in the Roadmap for moving to a low-carbon economy by 2050. *Source* The European Commission

sustainability in the long-run. Furthermore, less energy wastage and lower fossil fuel imports strengthen the EU economy: many studies show that early action allow to save money later.

The transport roadmap is of great importance too, because it includes 40 concrete initiatives for the next decade, with the overall aim to cut by 60 % transport GHG emissions by 2050 (compared to 1990). Key 2050 goals will include:

- no more conventionally-fuelled cars in cities;
- a 40 % of sustainable low carbon fuels in aviation use;
- at least a 40 % shipping emissions cut;
- a 50 % shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport.

In October 2014 the EU Council approved the "*2030 climate and energy goals for a competitive, secure and low-carbon EU economy*",[3] whose main goal was to reduce the EU domestic greenhouse gas emissions by 40 % below the 1990 level, by 2030. The rationale of this commitment is to ensure that the EU is on the cost-effective track towards meeting its 2050 objective, and to engage actively in the negotiations on a new international climate agreement that should take effect in 2020. To achieve the overall 40 % target, the sectors covered by the EU-ETS would have to reduce their emissions by 43 % compared to 2005. Emissions from sectors

[3]European Commission (2014) 2030 framework for climate and energy policies. http://ec.europa.eu/clima/policies/strategies/2030/index_en.htm.

outside the EU-ETS would be cut by 30 % below the 2005 levels. This effort would be shared equitably among the Member States.

Since renewable energy should play a key role in the transition towards a competitive, secure and sustainable energy system, the Commission proposed an objective of increasing the share of renewable energy to at least 27 % of the EU's energy consumption by 2030; the European Council endorsed this target, which is binding at EU level but would not be translated into national targets through the EU legislation. An EU-level target on renewables is judged necessary to drive continued investment in the sector, but has been preferred to give Member States flexibility to transform the energy system in a way that is adapted to their national preferences and circumstances.

The European Council endorsed also an "indicative target" of an energy efficiency increase of at least 27 %, to be reviewed in 2020 having in mind a 30 % target.

It is worth noting that in the EU Budget for the 2014–2020 period approved by the European Parliament in November 2014 at least the 20 % of the total budget (about 180 of 960 billion euro) should be spent on climate change-related action, also with an estimated 14 billion euro over the years 2014–2020 for climate spending in developing countries.

1.4 UE Submission to UNFCCC

In March 2015 the EU and its 28 Member States submitted to the United Framework Convention on Climate Change (UNFCCC) their Intended Nationally Determined Contribution (INDC), where the EU declared to be "*fully committed to the UNFCCC negotiating process with a view to adopting a global legally binding agreement applicable to all Parties at the Paris Conference in December 2015 in line with the below 2 °C objective*". With its INDC, the EU as a whole entity assumes a unilateral binding target for at least 40 % domestic reduction in greenhouse gas emissions by 2030 compared to the base year 1990. This target will be reached only with domestic measures, without contribution from international credits, whereas the inclusion of emissions or removals from Land Use, Land Use Change and Forestry will be decided in the future.

In the submission, the EU States declare that the binding target for the year 2030 is in line with the EU objective established in the 2050 roadmap, which is the reduction that all developed countries as a group should reach to be consistent with the need for at least halving global emissions by 2050 compared to 1990.

In 2013, the EU and its Member States have already reduced their emissions by over 20 % on 1990 levels, while gross domestic product has grown by more than 45 % over the same period. As a result, average per capita emissions across the EU and its Member States have fallen from 12 tonnes CO_2eq. in 1990 to below

9 tonnes CO_2eq. in 2013 and are projected to fall to around 6 tonnes CO_2eq. by 2030.

It is worth remembering that these emission reductions are assessed using a production-based approach, that considers emissions effectively occurred in the EU territory, whereas including indirect emissions related to the overall consumption in the EU (i.e. carbon emissions embodied in internationally traded goods and services), the reduction is far less relevant.

1.5 UE Action on Adaptation to Climate Change

Scientific evidence indicates that even in the most ambitious emission reduction scenario, significant preventive and remedial adaptation efforts around the globe are needed, in order to reduce vulnerability and to increase resilience to the effects of the climate change.

The EU policy on adaptation is recent and is aimed at enabling local and regional public and private sector actors to develop cost-effective adaptation options. Low-lying areas close to the coast, river catchments and mountainous areas are particularly vulnerable to climatic changes; the economic sectors that depend on weather, like agriculture, fisheries, forestry and tourism, are exposed to a higher risk than other sectors, thus they have a greater need to adapt to climate change.

The EU has established a wide range of guidelines and projects that created the framework for the development of the EU Strategy on Adaptation to Climate Change, adopted by the Commission in April 2013:

- A White Paper on adapting to climate change (2009);
- Guidelines for the elaboration of Regional Climate Change Adaptations Strategies (2009);
- Guiding principles for adaptation to climate change in Europe (2010);
- Adaptation Strategies for European Cities (2012);
- A European climate adaptation platform (Climate-ADAPT), repository of adaptation information in Europe including adaptation case studies, potential adaptation measures and tools that support adaptation planning.[4]

The EU Strategy on Adaptation provides funds to Member States to help them build up their adaptation capacities and take action, but is also intended to support an adaptation in the cities by launching a voluntary commitment based on the Covenant of Mayors.

At the moment, 15 Member States have already developed national adaptation strategies, and twelve more are in the process of doing the same thing. Many

[4]European Commission (2012) Climate Change Adaptation in Europe. http://climate-adapt.eea.europa.eu/.

regional and local responses are also emerging, focusing on specific social-economic conditions and needs, as well as local environmental impacts.

Finally, in March 2014 "Mayors Adapt" was launched, as an initiative of the European Commission—DG Climate Action to provide a framework for local authorities to take action on the second of these elements.[5]

[5]European Commission (2014) Promoting urban leadership in adaptation to climate change. http://mayors-adapt.eu

Chapter 2
Nexus Approach to Disaster Risk Reduction, Climate Adaptation and Ecosystems' Management: New Paths for a Sustainable and Resilient Urban Development

Adriana Galderisi

Abstract The "nexus" approach has recently been widely interpreted as a groundbreaking vision for dealing with existing and emerging environmental challenges. Therefore, we will focus here on the potential for extending the nexus approach to some of the factors threatening the future development of urban areas and, namely, to individual and coupled hazards, climate change and environmental degradation. These factors are currently faced in different ways by individual institutions and policy developments that are still far apart, despite the fact they interplay and overlap at different levels and would require cross-sectoral strategies and measures to coalesce. This contribution will first explore the potential of the nexus approach to shed light on the complex interactions among natural, technological and na-tech risks, climate-related impacts and ecosystems' degradation. Then, the need to develop an integrated knowledge base for more effective interventions to drive cities towards a sustainable and resilient development will be discussed.

2.1 Introduction

The increasing frequency and severity of natural and human-induced disasters, often linked to extreme weather events, is causing considerable damage in Europe, especially in urban areas. The latter, characterized by an increasing density of people, goods and equipment, are often the result of development paths that have been largely geared to soil consumption and sealing, paying little or no attention to the issues of risk prevention and mitigation.

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We will explore in the following the complex linkages among ecosystems' degradation, climate change, risks and urban development, in order to provide hints for developing a cross-sectoral approach to these issues, emphasizing the key role of urban planning processes. According to this goal, the contribution is structured as follows:

- firstly, the interdependencies among urban development, ecosystems' degradation, climate change and natural, technological and climate-related risks will be analyzed;
- then, the main steps towards a better integration among the considered issues will be presented, focusing on the EU research projects as well as on the scientific and institutional debate;
- finally, the potential for applying the nexus approach to the challenges posed by the interdependencies between natural dynamics and human activities will be discussed.

2.2 Interdependencies Among Environmental Degradation, Climate Change, Risks and Urban Development

Urban population is increasing all over the world: Europe is one of the most urbanized countries in the world and, according to the 2014 World Urbanization Prospect, urban population is expected to further increase from 73 to 80 % by 2050. In the meantime, starting from the Nineties, "urban areas [in Europe] sprawled faster than population growth" (EEA 2013). According to the scenarios developed by the Espon Project, land consumption will continue to increase mainly in Western Europe, showing a slight decrease only in Eastern Europe (van Delden and Vanhout 2014). Housing and recreation services, economic and industrial activities, transport networks and infrastructure are widely recognized as the main responsible of land consumption phenomena. The loss of natural, semi-natural and agricultural areas mainly affects Peri-Urban areas placed around major cities or along infrastructure networks, with significant consequences, ranging from a fragmentation of natural habitats to the loss of biodiversity and reduction in food production. Moreover, the sprawl of urban settlements often results in more resource-intensive lifestyles, because of the increased transport and domestic energy needs. This can "further increase the burden on ecosystems" (EEA 2015).

The growth of urban population and the sprawling of urban land uses across Europe have relevant repercussions not only on the consistency and quality of

natural resources, but also on natural and man-made risk levels. The latter depend indeed, on the one hand, on the various hazard factors affecting Europe; on the other hand, on the vulnerability of the exposed areas and assets. Hazards themselves are often increased by human activities: for example, soil sealing phenomena—due to the sprawling of urban land uses—significantly affect the cycle of water resources and, combined with increasing human pressure, further worsen the precarious geo-environmental balance of the European territory. Available statistics on hazards and risks (Munich 2013) show an increase in the total number of disasters in the recent decades, with a significant percentage of hydrological, meteorological and climatological events (tropical storm, flooding, mass movement, drought, heat waves, etc.) in respect to geophysical events, showing an almost stable trend in the time span 1980–2013. The European Environmental Agency has clearly identified river flooding and wind related storms "as the most important natural hazards in the EU in terms of economic loss" (EEA 2012).

Furthermore, in the last decades numerous natural events have induced major damage to hazardous industrial facilities, increasing the number of so-called na-tech events: this trend is expected to continue in case of more frequent climate-related hazards.

Another aspect to be remarked refers to the impacts of the heterogeneous hazard factors on natural and rural ecosystems. Despite the lack of detailed information and devoted databases on the impacts of natural, technological and na-tech hazards on these ecosystems, some types of natural hazards (e.g. climate-related phenomena as droughts or fires) may significantly affect natural resources, whilst technological and na-tech hazards always represent a serious threat to both natural and rural ecosystems.

Nowadays scholars largely agree that climate change is closely related to the growth of urban population, to the consequent conversion of natural and rural areas into urban land uses and to urban lifestyles. The expected growth of urban population will further increase energy consumptions and, if current lifestyles will remain substantially unchanged, the GHG emissions. Climate-related phenomena will increase current risk levels, "exacerbate existing environmental problems (…) and pose additional challenges to providing sustainable water and sanitation" (EEA 2015).

In Fig. 2.1 the complex interactions among human activities and natural dynamics are represented, shedding light on the inadequacy of the still prevailing sectoral approaches to environmental degradation, risks and climate change and the need, in order to reverse current trends, of innovative approaches capable to modify current urban development patterns through revised spatial and land use planning processes.

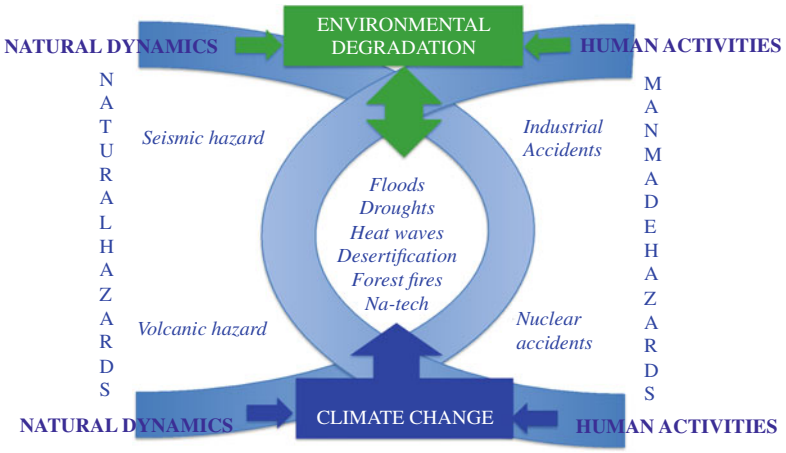

Fig. 2.1 The complex interdependencies among human activities and natural dynamics

2.3 Efforts Towards Integrated Approaches

In the face of the negative "loop" that characterizes interactions among human activities and natural dynamics, the recent debate on Sustainable Development Goals has been largely focused on the need for better integrating development goals and environmental sustainability, emphasizing that the "integration is not only possible, but necessary" (Boltz et al. 2013).

Moreover, in the last decade large room has been devoted to the concept of "mainstreaming", interpreted as the informed inclusion of significant environmental concerns into decision-making processes at different levels. Various steps have been undertaken in the last decades in order to better integrate:

- environmental issues into land use planning processes;
- risk issues into land use planning;
- climate concerns into urban development policies.

The integration of environmental issues into land use planning processes has received large attention starting from the Nineties and the main outcome is related to the widespread application of the Strategic Environmental Assessment (SEA), introduced by the EU Directive 2001/42/EC. The SEA has significantly improved land use planning process, by ensuring the consideration of environmental, social and economic sustainability issues along the different steps of the land use planning process (Galderisi and Profice 2012).

However, the SEAs so far developed across Europe are largely focused on the impacts of land use planning choices on consistency and quality of environmental resources (water, soils, air, etc.), neglecting the multiple interrelationships between land use planning choices and alteration of the natural environment on risks, climate change and climate-related hazards.

Instead the key role of land use planning tools to minimize natural hazards related risks has been acknowledged in literature (Burby 1998; Walker et al. 2011) and steps forward have been taken in the last two decades at the European level.

Past EU research projects—such as the "Applied Multi Risk Mapping of Natural Hazards for Impact Assessment (ARMONIA)" funded under the VI FP—have produced frameworks to guide planners in analyzing different risk components in order to assess the compatibility of alternative land uses with existing hazards and risks (Galderisi and Menoni 2007). Most of the hints provided by the Armonia Project have been embedded in the working paper on "Risk Assessment and Mapping Guidelines for Disaster Management", issued by the EU in 2010, that represents a significant progress towards an effective multi-risk analysis. The Guidelines point at the need for involving multiple stakeholders in risk assessment processes and ensuring extensive public information on the process and outcomes of risk assessment.

Recently a growing attention has been paid to climate change and many scholars have emphasized the need for a climate sensitive land use planning, addressed to reduce GHG emissions and adapting cities to climate-related impacts (Davoudi et al. 2009; Wilson and Piper 2010). Nevertheless, so far most of the initiatives addressed to counterbalance climate change have been carried out through sectoral plans, implemented on a voluntary base by Local Authorities and only few cities have started an effective path to integrate climate issues into ordinary urban planning processes.

Efforts have been also addressed to promote a better integration between climate policies and risk reduction strategies (EFDRR 2013; Kelman et al. 2015). Nevertheless, so far an effective integration between these areas seems far from being reached, neither in theory nor in practice.

Finally, it is worth mentioning the increasing number of studies addressed at exploring the potential of ecosystem-based measures for improving cities' response to natural and climate-related hazards and enhancing climate mitigation (Naumann et al. 2011; Estrella et al. 2013). In recent years, also the European Commission (EU 2015) has been devoting larger room to the development of nature-based solutions in order to address a variety of societal challenges, ranging from a more sustainable urban development to the recovery of degraded ecosystems, up to climate change adaptation and risk reduction.

Although the need for integrating the different areas of concern related to sustainability—comprising risks and climate change—is nowadays largely shared in institutional documents as well as in scientific literature, and some steps towards this goal have been undertaken, current knowledge as well as responsibilities and practices are still very fragmented. The main barriers to the development of an integrated approach are related on the one hand to the persisting difficulty to disseminate available knowledge out of the boundaries of the different scientific communities and even more to transfer research knowledge to practitioners and policy makers; on the other, to the current organizational structure of local governments. The latter are indeed often arranged into silos (GIZ and ICLEI 2014) and each of them, based on a single sector approach, is in charge of a specific issue: risk

reduction, water management, energy, transport. Such a structure does not encourage the required cross-sectoral approaches and strategies to address the complex challenges that cities have to deal with. Climate mitigation and adaptation, for example, are still mainly pursued through sectoral tools, scarcely related both to the existing DRR strategies as well as to land use planning choices and the potential of the SEA for evaluating the impact of land use planning choices on risk levels and climate change is still undervalued.

2.4 Potential of a Nexus Approach

The "nexus" approach is currently interpreted as a groundbreaking vision for dealing with emerging environmental challenges. Nevertheless, the actual difference between the emerging nexus approach and the holistic approach, largely debated since the Eighties, has to be firstly discussed. According to Hussey et al. (2015) a holistic approach "demands integrated or whole system research and policy approaches that may extend beyond our capacities, including too many variables and imperatives". On the other hand, the Nexus approach allows us to reduce the focus on some specific sectors and, in so doing, it might be more manageable and thus, more effective in guiding practices. The Nexus concept was firstly used in the early Eighties referring to the interdependencies between natural resources. Then, it was focused on the relationships between food and energy recognizing the "implicit water-resource dimension of the nexus between energy and agriculture" (Scott et al. 2015). Recently the Nexus approach has been further extended, by embracing the linkages among environment, health and well-being, and some attempts to provide ideas and tools for operationalizing such an approach are currently available (GIZ and ICLEI 2014). Also the Global Sustainable Development Report issued in 2015 highlights the interconnections among specific goals and suggests the adoption of a nexus approach to jointly analyze some issues for specific policy purposes.

Therefore, the complex linkages among environmental degradation, climate change, risks and urban development, briefly discussed in the previous paragraph, suggest the adoption of a nexus approach as a key for integrating current EU and cities' policies, assigning a key role to land use planning. The adoption of the nexus approach might in fact allow us:

- a more effective transfer of the theoretical and technical knowledge developed in each area of concern;
- an improvement of existing knowledge, currently too fragmented for effectively informing integrated policies on different scales, by better focusing on interactions and feedbacks among the different sectors;
- a shift from policies addressed to improve the capacity of urban systems in the face of individual issues or threats, towards policies focused on the adaptive capacities of urban systems in the face of multiple and interconnected factors.

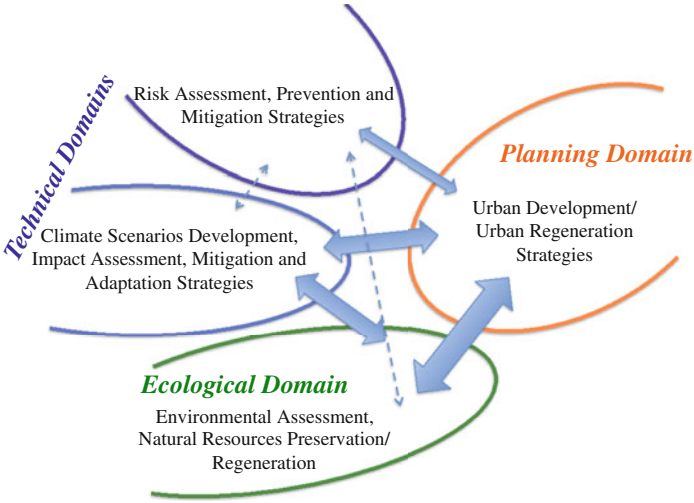

Fig. 2.2 The existing links among different domains (the *thickness* of the *arrows* indicates the greater or lesser interconnection between the considered domains; the *dashed lines* indicate the weakest links)

In respect to the first point, the adoption of a nexus approach might favor the building up of a common ground among different domains, too often separated in higher education programs as well as in research and in professional practice (Fig. 2.2). Nowadays, whilst environmental concerns are fairly included into planners' baggage and a growing attention is devoted to climate change issues as well as to the key role of natural ecosystems in counterbalancing climate impacts, persisting difficulties can be detected in transferring the significant body of knowledge on risks into land use planning and in promoting an effective sharing of existing knowledge between the fields of Disaster Risk Reduction and Climate Change Adaptation. Hence, a relevant effort should be invested into better integrating theoretical and technical knowledge developed on risk issues, and often confined into a very sectoral domain, into urban planners' education and training. The building up of a "safety culture" among planners is crucial, indeed, to effectively progress towards risk informed decision-making processes aimed at urban development.

Moreover, despite the role of natural ecosystems is nowadays acknowledged as a key element to counterbalance both natural and climate-related hazards, ecology does not make part of the educational curricula of experts in risk prevention and mitigation, nor ecologists are involved by the latter in working groups.

The weak link between these fields of competence has a twofold consequence: on the one hand, the impacts of natural and climate-related hazards on natural resources are often undervalued or neglected; on the other hand, ecosystem management is rarely considered as part of the portfolio of solutions to Disaster Risk Reduction.

Furthermore, even though green measures are nowadays widely interpreted as a key tool to counterbalance climate change, they represent only a first step towards an ecology-based urban development. A quite radical change in current pattern of resources' consumption in cities would be required, and, above all, the triggering of "comprehensive political, financial and technological strategies for an environmentally enhancing, restorative relationship between cities and the ecosystems from which they draw resources for their sustenance" (Woo et al. 2014).

The adoption of a nexus approach should be also addressed to strengthen the link between risk and climate change scientific communities.

Even though the dialogue between these two communities has been encouraged in the more recent years, barriers persist that hinder the development of a common language and the fruitful transfer of concepts, methods and results from one community to the other.

In respect to the second point, the adoption of a Nexus approach may significantly improve current knowledge. Current fragmentation of knowledge, often within the same disciplinary domain too, and persisting gaps in knowledge regarding interactions and feedbacks among elements and systems are the main barriers towards an effective understanding of the complex interdependencies among human activities and natural dynamics (Hoff 2011).

On the opposite, mutual learning and mutual knowledge generation across different domains might allow us to combine different ways of knowing and different actors who bring different types of expertise, driving existing knowledge beyond the sectoral/technical boundaries towards a systemic-oriented knowledge (Williams and Hardison 2013).

Current segmentation of knowledge is also mirrored in a fragmentation of competencies, responsibilities and operational tools at the professional and governmental levels that would significantly benefit from the nexus approach. The latter may induce a shift from "silo" approaches to the management of ecosystems, individual risks and climate change towards a more integrated and comprehensive management of the links between natural and human systems' dynamics. This is not a trivial challenge, since it requires first of all a cultural change, capable of bridging the different domains and, in so doing, to support the development of integrated strategies to the heterogeneous, although closely related, threats currently affecting cities. Secondly, it requires a significant organizational change that represents the third challenge implied by the adoption of the Nexus approach: separate institutional bodies in fact, which do not coordinate their activities, currently manage the different domains. A stronger cooperation/coordination among different sectors of local governments as well as among public and private stakeholders to tackle the interconnected challenges at stake is a prerequisite for promoting cross-sectoral strategies and initiatives. In this line, some European cities are building up resilience-oriented partnerships between different public actors/sectors and between private and public organisations addressed to better manage cross-sectoral projects, overcoming current segmentation of responsibilities and tasks. For example, the London Resilience Partnership, established in 2002, provides a mechanism for multi-agency cooperation to deal with large-scale emergencies (flooding, volcanic ash, Olympic games,

etc.). Similarly, the Barcelona Resilience Group, a public-private association established in 2008, is in charge of coordinating different sectors of local government, private operators, infrastructure owners, and other administrations to drive cross-sectoral projects for reducing urban vulnerability and guaranteeing the operational continuity of the city's services in case of hazardous events.

Finally, the key role that land use planning processes could play for making the adoption of a Nexus approach effective and capable to drive cities towards a sustainable and resilient development has to be emphasized. Urban planning processes should already ground on a systemic approach, allowing them to:

- collect and integrate different knowledge and information (arising from different disciplinary fields, developed at different geographical scales and referred to different temporal spans);
- take into account the complex interactions among different elements and systems (from the physical to the social, economic, environmental systems and their components);
- assess pros and cons of alternative land use choices, taking into account their immediate and future impacts on different resources as well as on different scales;
- prioritize strategies and goals by framing heterogeneous and sometimes conflicting goals as well as different stakeholders into a comprehensive vision.

Thus, urban planning processes might play a key role for overcoming "silo" approaches to the management of ecosystems, individual risks, climate change, favoring the application of a Nexus approach (Fig. 2.3).

To this aim, current methods and tools that currently characterize urban planning should also change. On the one hand, planners' culture and education should include the development of knowledge and skills on risks, climate change and ecology; on the other, roles and forms of urban planning tools should be re-designed as "frames" into which negotiate and reconcile competing and often conflicting objectives (Estrella et al. 2013), through "informed" and participated decision-making processes.

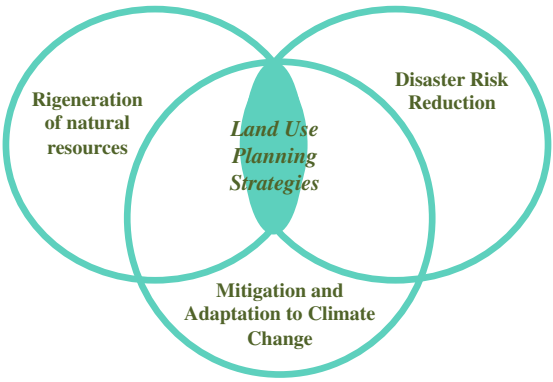

Fig. 2.3 The nexus for a sustainable and resilient urban development

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Chapter 3
Functions and Values of Peri-Urban Areas: A Multifunctional Perspective from EU to Lombardy Region Policies

Luisa Pedrazzini

Abstract The European Landscape Convention is the reference document for the Regional Landscape Plan (RLP) of Lombardy (PTR-PPR in Testo integrato degli elaborati approvati, 2010) that fully assumes its principles. The RLP covers the whole regional territory including "natural, rural, urban and Peri-Urban areas" providing dedicated policies by protection rules and addresses. In particular, great attention is paid to "landscapes that might be considered outstanding as well as every day or degraded landscapes". The new Regional Landscape Plan now under preparation focuses on a part of the Region defined as a "neglected area" in the present plan, covering the Milan metropolitan region and part of the Padana valley. This area is characterized by dense and sprawling urban settlements, residual open space, marginal agriculture, but also by valuable ancient rural settlements, monasteries and lasting countryside. It is therefore important to investigate character and typologies composing this space, involving about seven million citizens living or working there, in the perspective of strengthening the relationships between territorial and landscape planning and to enhance its multifunctionality.

3.1 "Everyday Landscapes" in the EU Context and in Lombardy

The Regional Landscape Plan of Lombardy assumes the principles of the European Landscape Convention (ELC), covering the entire region including "natural, rural, urban and Peri-Urban areas" providing dedicated policies. In particular, according to the ELC, great attention is paid to "landscapes that might be considered outstanding as well as every day or degraded landscapes".

For mature metropolitan regions and particularly for the European ones (Bbsr-Bbr 2012; Priorr et al. 2011; EC 2011a; TA2020 2011) the near future of

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marginal Peri-Urban areas, no longer agricultural in a full productive sense and not yet urban, is a very sensitive issue. A great number of European citizens are affected by 'Peri-Urbanization'. In a large European region like Lombardy (10,000,000 inhabitants), the metropolitan area of Milan involves about 7,500,000 citizens that daily affect their lives within the Peri-Urban environment. It is therefore important to investigate character and typologies composing this kind of "neglected areas", in the interest of strengthening relationships between territorial and landscape planning and to enhance their multifunctionality.

Concerning landscape and spatial planning and policies, this is nowadays primarily a question of 'potentials' in term of quality and functions of the metropolitan regions' outskirts. An integrated approach to face this issue is coherent with the ELC. According to Convention, landscape has to be managed «from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonize changes which are brought about by social, economic and environmental processes» (Council of Europe-Coe 2000). This assumes a comprehensive way to intend 'landscape', and its role, meaning and 'use', in improving involvement of citizens in building up a better environment. As well-known, Europe is a continent of towns and cities (75 % of citizens live today in and around cities) which means increases in both built up areas and Peri-Urban space. In fact, as emerged from project Pluriel, 48,000 km^2 are defined to be Peri-Urban and 49,000 km^2 are built up areas (Priorr et al. 2011: 10). This condition goes beyond the historic dichotomy between urban and rural areas, seeing that today in Europe Peri-Urban areas are more or less the same as urban areas.

To better focus on every day landscapes and in particular on the Peri-Urban issue, it is useful to consider the definition of the Council of Europe Conference of Ministers Responsible for Spatial/Regional Planning (Cemat): «Peri-Urban areas to be areas that are in some form of transition from strictly rural to urban. These areas often form the immediate urban-rural interface and may eventually evolve into being fully urban. Peri-Urban areas are places where people are key components: they are lived-in environments. The majority of Peri-Urban areas are on the fringe of established urban areas, but they may also be clusters of residential development within rural landscapes. Peri-Urban areas are most frequently an output of the process of suburbanisation or urban sprawl. […]» (Cemat 2007: 19).

Peri-Urban is not a new subject in planning or in economic and geographic discourses (Oecd 1979); but the approach is new. It considers the role and potential of these territories in the metropolitan regions of mature economies that are not considered simply places of transition from rural to urban functions but places with their own character with important potential. These 'intermediate' territories represent the interface between the EU citizens living in urban areas and the neighboring countryside, and the growing interdependence between urban and rural areas has been recognised. They are increasingly valued for their local production and resources, their diversity in landscapes, richness in cultural heritage and for quality of life. In later years, great attention has been given to this issue and many initiatives were promoted in Europe.

In 2010, the European Parliament agreed a preparatory action managed by the European Commission aiming to analyze and investigate urban-rural relationships named Rurban. It was oriented to promote urban-rural linkages supporting partnership and common initiatives between towns and cities and rural areas; encouraging territorial multilevel governance, exploring potential of rural-urban cooperation for economic development, regional competitiveness and regional governance. It was addressed also to promote the integration and the use of EU cohesion (Erdf) and agricultural funds (European Agricultural Fund for Rural Development-Eafrd) (EC 2011b). Amongst the diverse Rurban initiatives, a study was supported to put in evidence the character of urban-rural relationships and to sustain cooperation in the view to recognize Peri-Urban areas as a distinct kind of multi-functional territory. The concept of a Functional Urban Area was proposed as a proper way to define Peri-Urban as areas of transition but with a specific character (Bbsr-Bbr 2012: 5–10).

3.2 Focus on the Metro Region of Milan

The Regional Territorial and the Landscape Plans of Lombardy (PTR-PPR 2010) assume an integrated approach to correlate town and country planning and landscape planning, confirming particular attention to safeguard and improve open areas at territorial scale shaping a rural-landscape-environmental system involving natural areas and open spaces including the metropolitan region ones.

The urban region of Milan is characterized by a very high anthropic and environmental pressure (up to 6000 inhabitants/km^2), on air, soil, water pollution and traffic congestion, and a very high degree of land taking and landscape degradation. On the other hand, this region still resists a valuable agriculture production and a tradition of rural activities, the Lombardy region having been the first agriculture producer in Italy. The PTR-PPR and other recent projects worked out for the region of Milan drive to consider this area strategic in policies oriented to give a specific perspective to urban agriculture and a relevant role to Peri-Urban landscape (Pedrazzini 2014). Nowadays the "marginal" agriculture and the underused land of the city outskirts can play an important role towards a improvement of quality of life and a better urban environment of the metro region for citizens. The redesign of this wide (although "fuzzy") part of the region is important for both social, environment and economic reasons. The Peri-Urban landscapes are significant, and 'rurbanisation' seems a key word to describe a phenomenon that catalyzes the attention, and where now are converging policies and projects; sometimes derelict and marginal, these areas are not yet developed enough downtown and yet are no longer countryside; yet, they still conserve the historical rural genius loci and captivating capacity for citizens. Over the last decades, the only one effective performed policy to protect agricultural and green areas in the metropolitan region of Milan has been referred to the regional parks planning promoted during the 1990s by the Lombardy Region. The four regional parks (Agricolo Sud Milano, Groane, Valle del Ticino and

Nord Milano) surround the core of the metropolitan area and have helped to preserve and safeguard open spaces from settlements expansion in the past decades.

At present, one of the most interesting projects to be established in Lombardy is the 'Parco delle risaie' ('The rice field park'), consisting of recovering and revitalizing a large residual agricultural area in the South of Milan by promoting new agriculture, re-designing open spaces and green networks and restoring rural historical settlements. This project was established and promoted by citizens, Ngo's, private owners and farmers aiming to redesign the area. A further important initiative is referred to the establishment of the Milan Agricultural District—Dam (Distretto Agricolo Milanese) in 2011, to sustain agricultural production in the metropolitan city, with the motto: «Milano città di campagna». This initiative was promoted by a non-profit association, composed of a Consortium of 33 farms, seeking public interests but according to a professional agriculture. It covers a large part of the whole agricultural land of the city, having as main goals to maintain and secure agricultural production, but also to preserve the environment, and to protect landscape and cultural heritage, including rural buildings and farms. This approach to multifunctional agriculture, located at the edge of the city, identifies specialized functions on land that only a few years ago would be under the risk of abandonment and destined to be incorporated into urban settlements' expansion. Once the protocol was established between the Dam, the Municipality of Milan, the Province of Milan and the Lombardy Region in September 2011, the road map to the 'new-ruralization' of Milan was agreed to pursue: «un processo di neoruralizzazione di Milano» (Piano del Distretto Rurale di Milano 2011: 7–11). Further, other projects underway are pursuing the objective to maintain agriculture and the rural landscape of the metropolis, such as the framework agreement named 'Milano Metropoli Rurale' (Milan Rural Metropolis). The agreement was signed in 2013 by the Lombardy Region, Province of Milan, Municipality of Milan, Dam (Aqst Milano Metropoli Rurale), aiming to coordinate initiatives and projects of 'ruralization' of the metropolis by an instrument of governance. This experience marks a mile-stone and represents a turning point in the city's planning history, traditionally oriented to urban expansion. Indeed, in the city of Milan agriculture is still important; the dedicated surface amounts to about 4000 ha, which means 22 % of the whole municipal area is devoted to rural uses. The city is the second agricultural municipality in Italy and 128 farms are registered to the Chamber of Commerce. The outskirts of Milan are commonly recognized for their significant economic and productive value but also for public fruition, for historical, environmental and landscape assessment. In the Province of Milan agriculture surface represents more than one third of the total area.

Considering the sole core metropolitan area, this situation has been confirmed: 48 % of the area belongs to a regional agricultural park; 70 % of the population of the province of Milan live in a municipality belonging to a regional Park (2.1–3.1 Million/inhab.) and 50 % of municipalities are located in a regional park.

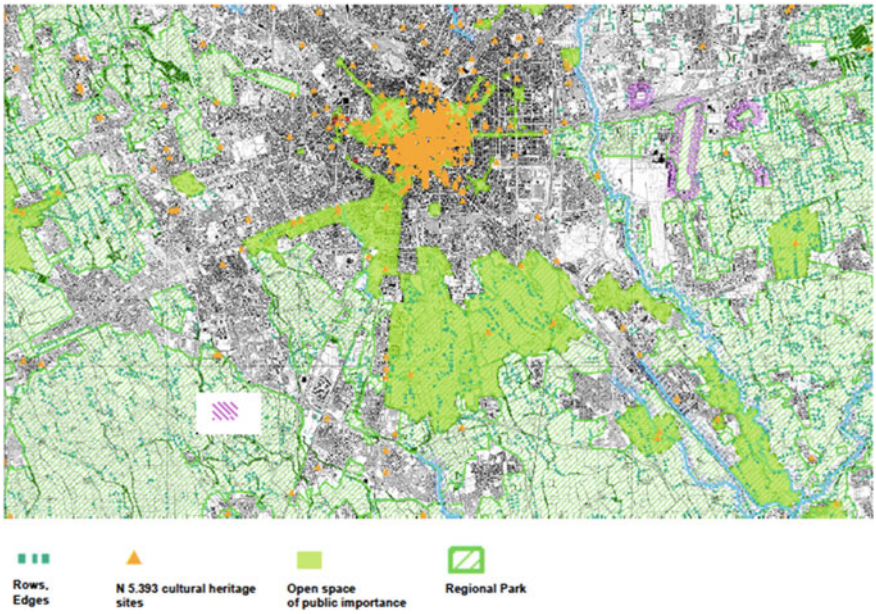

Fig. 3.1 *Green areas* and cultural heritage sites in South Milan (*Source* Regione Lombardia)

Nevertheless, the area is characterized by high atrophic and settlement pressure, with the highest population density in Italy and the sealing of soil up to 70/90 % to the North of the metropolitan region (Fig. 3.1).

3.3 New Perspectives for a Regional Policy

The focus of the new Regional Landscape plan now under preparation is on a larger part of the region defined in the present plan as a "neglected area", covering the metropolitan area of Milan and part of the Alpine valley floors which cover about 20 % of the whole region (Fig. 3.2).

Peri-Urban areas, historically involved in the competition between settlement expansion and agricultural/rural uses in the fringe areas of the metro regions, are now being given particular attention by public decision makers, citizens and farmers. A new role and dedicated policies are requested for marginal agriculture not only for ensuring agricultural products in proximity of the city but to further improve the quality of fringe urban areas according to a strong multifunctional and environmental vocation. It is further important to strengthen and give value to the historical heritage and cultural identity still present, giving a dedicated specific

status to this multifunctional space. According to this, the new Regional Landscape Plan promotes policies and projects aiming to sustain the agricultural attitude of the city (km 0 agriculture; short food supply chain), and acting against degradation of soil, land taking, environmental protection, with enhancing agrarian traditional landscape and historical settlements. The multifunctional attitude of the area performs many targets and activities such as: securing ecological services, cleaning and maintenance of the hydrographic network and open spaces, recovering and restoration of degraded landscape and environment. It presents also notable socio-economic potentials by promoting tourism in rural areas and securing social protection through the control of land under risk of abandonment, by recovering and re-using derelict and underused farms, by implementing urban green network and creating community gardens and allotments for citizens.

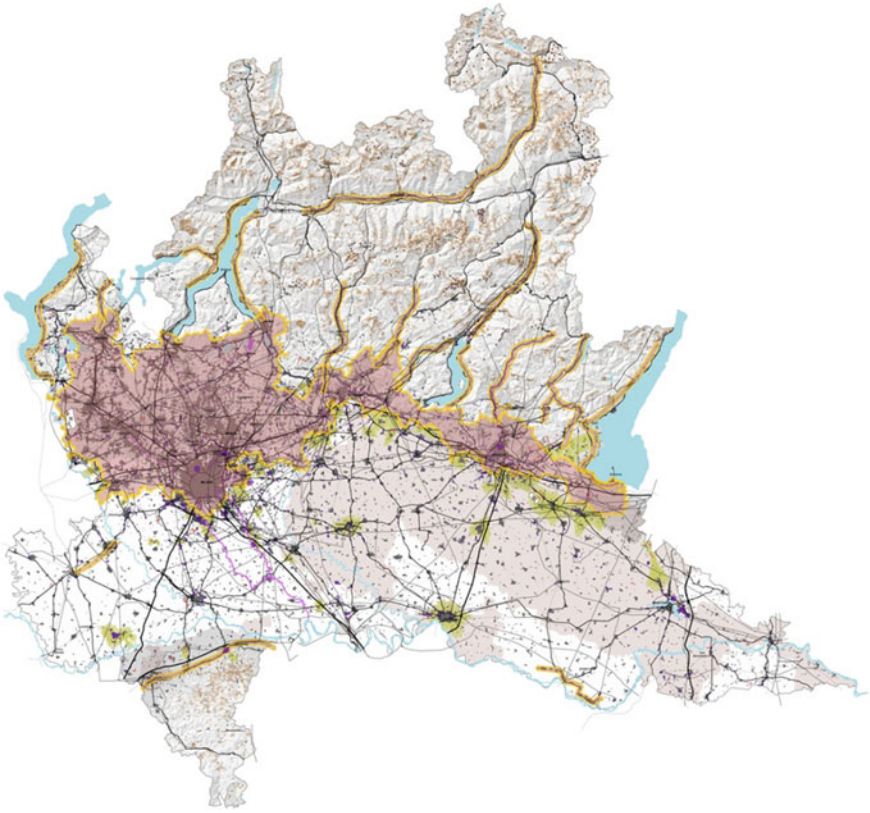

Fig. 3.2 Derelict areas in Lombardy (*Source* Regione Lombardia, Piano Paesaggistico 2010)

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Chapter 4
Urban-Rural Partnerships and Governance of Peri-Urban Areas in a European Perspective. Towards Regenerative Regions

Joerg Knieling, Marta Jacuniak-Suda and Andreas Obersteg

Abstract Urban-rural partnerships are project-oriented cooperation initiatives between different actors in metropolitan areas and their surrounding or more distant rural hinterlands, the aim being to establish stable but flexible cooperation structures. As such, partnerships can contribute to different goals of European spatial development: (a) they can support polycentric spatial development and create incentives for further urban-rural relationships (cf. CEC in ESDP European spatial development perspective, 1999, 20), (b) they recognize the mutual urban-rural dependency by integrated planning and steering based on a broad partnership approach, and (c) they link to the concept that metropolitan regions and their hinterland should build partnerships of joint responsibility for development of the cooperation area (CEC in Territorial Agenda of the European Union 2020 2011, 8). The chapter reflects upon the concept of urban-rural partnerships in Peri-Urban areas and its potential to contribute to regenerative transformation of cities and regions using selected case studies from the project INTERREG IV C URMA "Urban Rural Partnerships in Metropolitan Areas" (2012–2014). In addition, it addresses the findings of the INTERREG IVB SURF "Sustainable Urban Fringes" (2009–2012). Finally, the chapter explores potentials and restrictions of different forms of urban-rural cooperation with regard to regenerative regional development.

4.1 Urban-Rural Partnerships as Theoretical and Political Concept

Since the 1990s many of the western European cities have made attempts to intensify cooperation with their surrounding Peri-Urban and rural hinterlands in order to tackle inner-metropolitan disparities, and at the same time, strengthen the

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endogenous potentials for a more balanced territorial development. This trend has been intensified by the European Spatial Development Perspective (EDSP) which placed a focus on poly-centricity and new partnerships between the city and the countryside. In this context, the ESDP (CEC 1999, 21) states: "Cities have increasingly diverse functional inter-dependencies with their surrounding countryside. These interdependencies require voluntary co-operation across administrative boundaries between local authorities, to strengthen the region as a whole in competitive terms". Further, the Territorial Agenda 2020 acknowledges the leading role of metropolitan areas as drivers for the development of their wider surroundings. Here, the metropolitan areas can act as focal point for the development of the whole European territory, but under the condition that other neighboring regions benefit from their dynamism and are mutually interconnected (CEC 2011, 4–7). However, the role of metropolitan areas as engines of growth (cf. CEC 2011, 7 or IzR 2006, 708) is also limited, due to their structural problems, increasing socio-spatial segregation, polarisation processes and inner-metropolitan peripheralization (Danielzyk 2012, 31). Therefore, development impulses can also emerge from economically vibrant rural to urban areas.

In addition to the cohesive aspect of spatial cooperation, the concept of the "regenerative city" (Girardet 2010) or "regenerative region" (Droege 2014) presents another perspective for analysing urban-rural partnerships. The first concept underlines the importance of enhanced relationship between cites with their natural ecosystems whose resources they depend on. In contrast to the current state of the city as a "Petropolis", powered by and dependend on fossil fuels, the future vision is the transition to "Ecopolis", the regenerative city, by turning the urban-regional metabolism from a linear into a circular model (Girardet 2013, 8–9; Girardet and Mendonça 2009, 174–175). Compared to "Petropolis", the "Ecopolis" provides a compact city development charactarised by a zero emissions transport system, a high level of energy efficiency, the use of local renewable energy, biodiversity in landscape design and a city embedded in its hinterland using urban-rural-relations in fields like agriculture, food production, renewable energies etc. This all will lead to a significantly smaller ecological footprint. The more elaborated the circular metabolism, the closer the city and region are to the regenerative vision. This vision is strongly in correlation with the NEXUS concept as presented in this book.

The concept of "regenerative region" (Droege 2014, 23) acknowledges the pivotal role of regions as domains of responsibility and spaces where settlement planning and development take place. But most importantly, regions can become arenas for "the inevitable transition to the large scale, cross-boundary energy supply based entirely on regenerative resources" becoming the very model of sustainable spatial development (Droege 2014, 18). Besides the highlighted role of renewable energies the "regenerative region" includes many other action fields which are characterized by a circular understanding and thus contribute to sustainable development.

Fig. 4.1 Regions involved in the project INTERREG IV C URMA "urban rural partnerships in metropolitan areas" (2012–2014) (Jacuniak-Suda et al. 2014c, 10)

Against this background urban-rural partnerships can be understood as territorial as well as project-oriented cooperation initiatives between different actors in metropolitan areas and their more distant rural hinterlands with the aim to establish stable but flexible cooperation structures contributing to circular metabolism of cities and regions and the enhancement of regional food and energy chains. In particular, urban-rural partnerships can be characterised by the following selected features· which can be recognised as relevant in the context of regenerative regions: partnership on a level playing field, sharing of benefits, resources and cost, cross-sectoral actors participation and variable geometry (cf. Jacuniak-Suda et al. 2014a, 20–22) (Fig. 4.1).

4.2 The Regenerative Potential of Urban-Rural Partnerships in Peri-Urban Areas in Italy and Germany

This chapter provides an overview of selected findings identified within the framework of an URMA project that illustrates the implementation of the concept of urban-rural partnerships in Peri-Urban areas of Lombardy in the light of the concept of regenerative cities and regions. In addition, the findings of the SURF project in the Hamburg Peri-Urban area enrich the discussion on the lessons learnt.

4.2.1 Management and Governance of Peri-Urban Areas in Lombardy (Italy)

The Lombardy Region presents an urban-rural cooperation within an inner part of the metropolitan area, in particular between the metropolitan core of Milan and its Peri-Urban areas. The natural and cultural landscape of Milan is characterized by natural river bodies, well-structured historical channels and irrigation systems, historical centres and heritage buildings. The agricultural landscape includes agricultural parks (Agricultural Park of South of Milan) as well as a high percentage of farms with differentiated agricultural production. Therefore, the case study provides an example of the management and transformation of multifunctional Peri-Urban areas. In particular, in the face of ongoing urban sprawl, the preservation and future management of rural elements in Peri-Urban areas presents a challenge.

A model approach to tackle this challenge offers the Parco delle Risaie, an urban-rural park located in the south-western part of Milan's metropolitan area, in the municipalities of Milano, Assago and Buccinasco. Parco delle Risaie Association was founded in 2008 by local farmers and citizens and since then has promoted traditional rice production, local food chains, multi-functional agriculture and landscape improvements. A number of events involving citizens, local communities and other associations take place throughout the year with the aim to communicate the value of the park. The park operates by the means of the spatial concept developed for the area with the aim to enhance and promote open spaces in the city, giving value to the agricultural character and to deliver environmental and landscape services that are only partially developed (ROSPWV 2014, 9).

An innovative approach towards the creation of urban-rural partnerships is an operating instrument of "Ecological Urban-Rural Agreements" proposed by the Lombardy Region within the URMA project. The instrument was developed in order to encourage the development of partnerships between involved urban and rural actors (farmers, associations, entrepreneurs, public bodies such as water ways management or regional administration, etc.) and stimulate a more effective governance of Peri-Urban areas of Milan. A novelty also presents the elaboration of a differentiated typology of spatial categories for Lombardia (regeneration areas, transformation areas) based on the regional data analysis undertaken within the framework of the URMA project. For the first time the particular functions and values of Peri-Urban areas in Lombardy were examined (Jacuniak-Suda et al. 2014b, 14).

Summing up, the management of Peri-Urban areas towards a regenerative region calls for an integrated approach by means of cross-cutting policies and initiatives as well as effective governance structures.

4.2.2 *Management and Governance of Peri-Urban Areas in the Hamburg Metropolitan Region (Germany)*

The Hamburg Metropolitan Region accommodates a number of projects with the focus on energy, food, climate change and land use. Worth mentioning is the inter-state inland waters flood protection project, research project KLIMZUG-NORD—strategies adapted to climate changes and the promotional project on regional food chains "Aus der Region für die Region" (From the region for the region).

An example of regenerative potential of Hamburg and its Peri-Urban areas was the project "Sustainable Urban Fringes" (SURF, 2009–2012). The project partners across the North Sea Region recognized that cities rely on the ecological services provided by the surrounding fringe area. In particular, eco-system services and green infrastructure contribute to sustainable urban planning and present an opportunity to bridge the gap between urban and rural policies and create a new flexible policy which can in particular benefit the development of Peri-Urban and subsequently urban fringe areas. SURF identified that both the Peri-Urban and urban fringe suffer from similar obstacles, such as identifying ownership of land, issues with limited connectivity and lack of identity (cf. SURF 2012b, 1–3).

Hamburg's "suburbia", for example, presents a highly politically and administratively fragmented area. City districts in Hamburg have limited power compared to the municipal level in other federal states. Therefore, they are not authorized to coordinate planning with neighboring counties or municipalities.[1] In order to overcome this gap and enhance the strategic ability of local planning by the means of the integrated approach local, level-driven, cross-border neighbourhood forums have been established since 2007. The involved actors—representatives of municipalities and city districts, federal state officials, associations and regional and city planners—identified revitalization of existing housing stock, better accessibility via public transport, revitalisation of suburban open spaces as well as energy efficient and climate friendly settlement development as core action fields to be addressed. By applying instruments such as inter-communal projects, regional monitoring, project workshops effective guidance to sustainable management of Peri-Urban areas can become reality (HCU 2013, 86–87). Moreover, the City of Hamburg in cooperation with HafenCity University Hamburg employed a tool "colloquium series" open to public to raise awareness and knowledge on services offered by urban fringes (SURF 2012a, 18).

[1]SURF workshop Hamburg presentation from 18.01.2013., see also the constitution of the Free and Hanseatic City of Hamburg from 6 June 1952, article 4 (1), according to which the state and communal affairs are not separated http://www.hamburg.de/contentblob/1604280/data/verfassung-2009.pdf (accessed 07.09.2015).

4.2.3 Conclusions and Lessons Learnt

The aim of this chapter was to reflect upon the concept of urban-rural partnerships and its implementation using selected case studies from the INTERREG projects URMA and SURF with regard to regenerative urban and regional development.

A precondition for the emergence of urban-rural cooperation in the presented Peri-Urban areas was the jointly perceived need for more effective cooperation among the involved stakeholders, based on acknowledgement of mutual benefit. This need arose in the cases in response to various threatening circumstances: the danger of rampant suburbanization, the loss of value of Peri-Urban areas and environmental degradation. The solutions developed to these challenges clearly reflect the growing awareness among political elites and regional stakeholders towards the need for regenerative transformation of the cities and their hinterlands using co-operative forms of urban-rural partnerships.

Still, a number of lessons can be learnt for the future. First, there is a need for recognition of opportunities and values of Peri-Urban areas, in particular ecological services and space for renewable energies they offer. Second, effective guidance to organization and management of Peri-Urban areas can be an enabler for social cohesion, economic growth and sustainable development. Third, the development of a specific urban fringe policy that bridges the gap between urban and rural policy is highly required (cf. SURF 2012b, 1–4). In the perspective of a "regenerative region" urban-rural partnerships can contribute to reducing urban sprawl and to strengthening regional food and energy chains. As a result, transport costs and environmental pollution can be minimized. In addition, a better regional communication and coordination of development initiatives can be achieved.

The analysis of selected case studies indicates that the regenerative transformation of cities and regions cannot be merely limited to energy transformation, but should follow a holistic approach based on a closer cooperation of urban and rural actors in the field of regional product chains, sustainable land management, as well as public participation in local decision making. However, an effective city-regional and multi-level governance structure is a precondition of regenerative cities and regions.

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Chapter 5
Qualify Decision Making Through Strategic Environmental Assessment: Advancing the Resilience of Peri-Urban Areas

Mara Cossu

Abstract The displacement between the intentions of the decision making process and the continuous changes that territories undergo, both planned and unforeseen, calls for an unused "territorial consistency" of planning. Thus, it requires widening its capacity in taking into consideration the whole decision making means overlaying on concerned territories. Strategic Environmental Assessment (SEA) can be a reliable support to this shift. Through the case study of joint SEA of the EU funded Regional Operational Programmes 2014–2020 in Lombardy Region (IT), the contribution argues the potential role of an assessment approach based on a wide, shared and territorial based sustainability framework, drawn in order to properly face dynamic spatial scenarios. It is shaped to accompany the decision-making process and ensure a long-term link between spatial changes and single planning or programming activity. To outline spatial scenarios, all factors are supposed to determine the actual spatial dynamics and thus are considered and conceived as directly impacting the *resilience* and the *vulnerability* of territorial systems. This space-based approach results in acknowledgment of the value of Peri-Urban areas in terms of ecosystem services provided to urban areas as well as environmental, social and cultural relevance per se. While the urgent need for such a role to be recognized is apparent, the lack of ad hoc policies in Italy stands evident, also due to an unwillingness to integrate sectorial courses of action within a territorial focus. The proposed case study delivers specific sustainability conditions for the implementation phase, in order to bridge single provisions on Peri-Urban areas.

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5.1 Planning for Resilience, Dealing with Uncertainty[1]

Decision making process can be described as composed of a multiplicity of plans and programmes characterized by procedural autonomy. They show own peculiarities relating to several aspects:

- *Territorial scale and reference sector*: every plan involves a certain territory. The same territory can be concerned by several sectorial and territorial planning instruments, such as regional, county and local plans, although through different roles, duties and scales;
- *Implementation rules and tools*: planning implementation can be direct—through tenders, public announcements, etc.—or it can imply subsequent planning levels with specific implementation plans or programmes;
- *Times*: every plan has its own timeline. Furthermore, its influence and foreseen implementation tools can overpass expected deadlines and delay for an unpredictable time;
- *Actors*: plans concerning the same territory partially involve common actors and stakeholders, depending on the reference sector of the plan and on its territorial dimension. For this reason, participation activities should be properly structured, and should follow the whole decision making process .

To face real time planning and ensure the resilience of territories, as well as to deal with the uncertainty of the implementation phase and of unplanned factors and events, planning and evaluation activity are to be considered within their comprehensive container, the decision making process. It is dynamic by nature and links plans, policies, programmes and related implementation tools into a territory–tied system.

Resilient territories and cities ought to face the spatial and temporal declinations that shape their implementation tools. They have to be able to revise them, rapidly identifying and interpreting on-going transformations.

Monitoring and participation are key elements to verify the sustainability of decision making for resilient territories, being shaped as tools for measuring the ability of responding to on-going phenomena. They are to be designed not just to advance general understanding, but for their relevance to informing potential future decisions (Parson 2001, 348).

A continuous territorial monitoring should drive decision making, ensuring its *adaptivity* within a constant process of building and updating a system of knowledge related to territories and people (Holling 1978). To increase the resilience of territorial systems, territorial arenas shall be open, shaping permanent forums

[1]The theoretical basis for this contribution comes from a revision and update of the paper *Environmental monitoring and planning: joining forces for facing changes*, by Laniado E., Cossu M., Vaghi S., in "REAL CORP 2013—Proceedings of 18th International Conference on Urban Planning, Regional Development and Information Society". Roma, 21-24 maggio 2013, edited by Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI.

allowing the reliable participation of experts and of the public. They could work alongside the whole decision making process, also contributing to the assessment of monitoring outputs.

In this view, it seems crucial to concentrate on the territories which planning refers to and on the relationship they engage with the governing instruments. External elements affecting concerned territories are also to be considered for reaching further decisions. This "chain of relationships" is to be inserted within the decision process to acknowledge and support its potential in increasing the resilience of territorial systems.

In such a dynamic interaction, the assessment of territorial effects produced by a single plan or policy seems to be puzzling and particularly demanding.

An environmental context is part of a territorial, dynamic system. It undergoes continue transformations. The act of understanding which part of occurring changes on addressed areas can be ascribed to the implementation of a single plan can be particularly demanding.

Under this general framework, the introduced approach shows the potential of Strategic Environmental Assessment (SEA) process to manage the complexity of territorial transformations and the assessment of programme-led effects.

5.2 The Strategic Environmental Assessment of the 2014/2020 EU Funded Programmes in Lombardy Region

Complex territorial systems are characterized by a high level of social and economic uncertainty. Furthermore, they suffer the evident climate change and the multiple effects caused by anthropic activities.

EU funds are expected to finance *objects* and *activities* which will have a direct influence on environmental balances and on landscape qualities in both the middle and the long term. SEA is then expected to define and assess hardly predictable scenarios. This challenge requires an adequate approach for reading and rendering the whole variables on the ground and the interactions they engage each other.

This awareness led to deliver a joint environmental assessment for both 2014/2020 ERDF and EARDF Programmes in Lombardy, interpreting the SEA process as a laboratory of innovation at regional level.

A peculiar assessment approach has been defined, based on the use of the concepts of resilience and vulnerability of territorial systems as elements which allow delivering consistent descriptions of the on-going territorial dynamics. They also are recognized as capable of describing the ability of different territorial units of responding to occurring changes. Such capacity is simultaneously determined by external pressures and by qualifying or jeopardising internal elements.

Within this approach, the vulnerability of a territorial unit is defined as its disposition to instability and to the deterioration of structure and composing elements (i.e. rural areas within urban fringes suffering from increasing soil erosion). On the other hand, resilience is intended to be the capacity to adaptively respond to changes, largely depending on the quality of the resources belonging to the considered territorial system, on the main environmental challenges, on the size of the dynamics and on the pressures they respond to and depend on (i.e. rural areas in urban fringes enacting strategies of multifunctionality for adapting to occurring urban sprawl dynamics).

In this vision, concerned territory is the focus upon which changes shall be continuously monitored and described through proper shared data and indicators. The assessment has then been oriented to estimate the existing vulnerabilities within the addressed territories, as well as to identify the dynamics of resilience, both potential and enacted.

A territorial framework has been displayed, aimed at defining a common support to the whole decision making acting on the Region and allowing an unusual potential in properly assessing cumulative effects. The single plan or programme is then expected to identify its own thematic assessment keys while reflecting on its comprehensive contribution to identified territorial trends.

This process leads to the definition of **territorial based assessment outputs**, criteria, priorities and indicators among the others, as depicted in Fig. 5.1.

Territorial and environmental dynamics have been interpreted per sè, delegating to each planning mean the need of demonstrating how it contributes to changes underway, fully applying the strategic spirit of the SEA. This results in the unburdening of the single process from context based analysis.

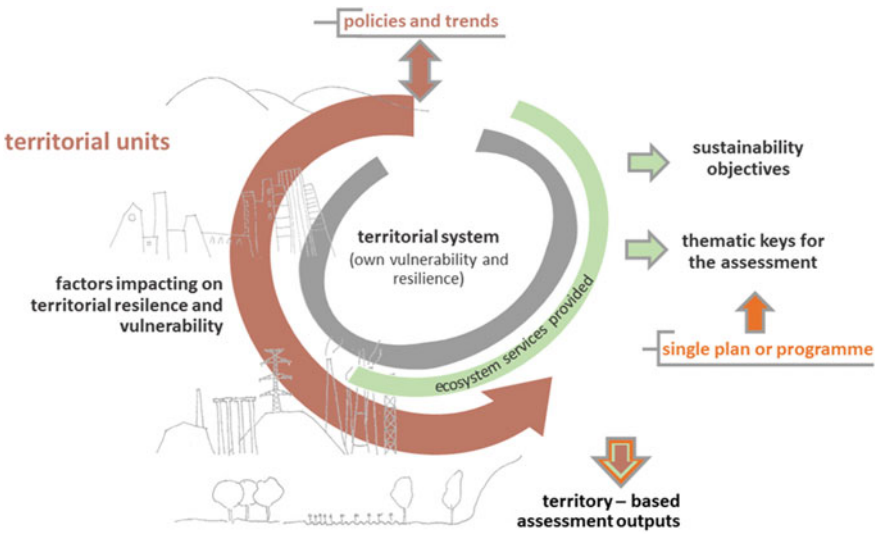

Fig. 5.1 General approach scheme

Also, it challenged the formal approach to environmental assessment, overwhelmed by procedure, which is spreading among public entities in charge of the assessment. Furthermore, it represents an attempt of shifting questions arising from the issue of *value* from the single assessment instrument to a more comprehensive territorial level. In this sense, environmental assessment can be a ground for learning by planning theory, where universal paradigms and approaches has been in time put under discussion.

The development of planning theory has not been about the adoption of a central paradigm, but about the gradual emergence of a more contested territory, where overarching theories have failed to convince the academic community that they are as universally relevant as they might claim (Richardson 2005, 343).

Following this argument, the disappearance of universal approaches should lead to a more context-based inspiration for environmental assessment and planning that has to engage with *competing multiple rationalities* and with conflicts arising from the different *values* they represent and bring into the policy-making arena. A tentative and collective ongoing process, led by the so-called adaptive management (Holling 1978) allows establishing an iterative territorial learning process enriching knowledge and delivering short term outputs for management.

5.3 The Contribution of a "Peri-Urban Arena"

EU Cohesion Policy 2014/2020 rules assign to urban areas specific funding and attention. On the other side, Rural Development Programmes do generally consider Peri-Urban areas as benefiting by an advantageous position and in the past programming periods often excluded them by the fundable areas.

The Regional Territorial Plan in Lombardy recognizes the metropolitan system as a whole, identifying specific objectives and strategies. It foresees, among the others, the promotion of integrated development strategies for urban/rural development and for controlling the sprawling of cities.

Following this approach, the SEA process for EU programmes delivered a specific thematic focus on urban rural systems, attempting to promote an integrated approach to funding in such areas.

Experts and stakeholders were invited to develop a common point of view and to gather strategic elements to be provided to the Managing Authorities of each Programme to fully integrate the programming documents and to qualify their implementation on Peri-Urban areas.

Experts' suggestions and proposals mainly referred to integrated dimensions and approaches and call for strategic and integrated planning. The SEA attempted to bridge urban and urban/rural areas through proposing an integrated approach, seeking to overpass at regional level the lack of operational elements for easing the use of integrated instruments in EU 2014/2020 cohesion policy. A preliminary appraisal of the activity can be outlined at this stage.

First of all, the outputs of the produced interaction shaped the contents of the environmental assessment documents, with specific reference to sustainability criteria for the implementation phase. Also, they have been hugely discussed with the Managing Authorities to sustain their full insertion, in different forms, within the implementation documents.

For the first time, the Rural Development Programme reduced the dimension of urban areas, which are not admissible to funding, providing a new boundary delimitation compared to 2007/2013. Peri-Urban areas are then fully fundable and part of the overall agricultural strategy, displaying a full acknowledgement of their rural value. The relevant role of Peri-Urban farms is recognized, working on the enhancement of urban markets and exploiting proximity benefits.

From the ERDF point of view, the approach of eco—neighbourhoods was promoted, aiming at increasing environmental and social quality as a whole. Specific attention has been dedicated to the strengthening of urban accessibility and to the provision of blue and green infrastructures, integrating urban and Peri-Urban areas while increasing resilience, enhancing biodiversity, decreasing hydro geological risks.

Even so, despite a wide call for integration, there has only been a narrow available room for boosting integrated instruments.

A cultural work has been carried on, making the Managing Authorities aware of the importance to also adopt a Peri-Urban point of view and start *thinking SEA* (Therivel 2012, 263). Their increased awareness, supported by the provided environmental assessment tools and by the regional Environmental Authority activity, are hopefully expected to advance the capacity of the decision making to recognize the potential of such areas and allow integrated approaches to public action.

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Chapter 6
Services, Values and Functions of Peri-Urban Areas in a Nexus Approach

Luca Bisogni, Angela Colucci and Gioia Gibelli

Abstract This paper presents emerging questions and some perspectives based on the comparison between the first results of applicative researches and innovative projects developed by the authors. Researches and projects approach the topic of Peri-Urban areas integrating different competencies from different disciplinary backgrounds and developing planning and design solutions at different scales. The paper underlines in the first part the emerging questions from the territorial dynamics and the needs referred both to professional or disciplinary sphere (in terms of innovation in the approach, methods, tools…) and to governance and institutional sphere (in terms of innovation of competencies and institutional framework). The second part presents the main conceptual model on which the innovative applications developed are based (ecosystem services and green infrastructures). The final part underlines perspectives and main key issues for the development of integrated projects of Peri-Urban areas. The goals is to underline the emerging (and urgent) issues that can support an effective innovation in the planning, implementation and management at regional and local levels towards the improvement of the resilience proprieties of territorial systems.

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6.1 Emerging Questions. Peri-Urban Role in a Regional Vision

The relationship between "urban" and "rural" is conflictual: the two systems still remain opposed and antagonistic. There is instead an evident need of integration and synergy.

The impact of urban activities on the rural system affects different ecological dimensions such as: water quality and quantity, biodiversity erosion and chemical pollutants emissions that have repercussions on the ecological system, but the main issue is the competition for land exploitation between urban expansion and farming (Svedin 2011; Pareglio 2013).

This conflictual relationship still exists and is recognisable in several polices, in both cultural and scientific fields andit affects projects and proposals. The gap is overcome only considering the "urban" as a complex system at regional scale where the resources and services that support the development of the city are out of the urban patterns itself, but are an integrated components.

In this approach the Peri-Urban areas are interpreted as territorial patterns with their specificity but they are integrated components of complex territorial systems with the same relevance of the other components: urban, rural and natural components and related patterns.

Peri-Urban areas play a central role in the definition of future strategic vision for the regional and the "metropolitan" development.

6.1.1 Complexity of Interdependencies

Adequate knowledge needs renovated tools able to describe new phenomena emerging from interactions between complex territorial dynamics: environmental/ecosystems and metabolic flows and cycles, social aspects and economic trends and phenomena, governance and political trends.

The environmental and ecosystem components are related to social and human components: cultural traditions, local community perception of landscapes, agricultural/food chain systems and social phenomena have impacts (positive or negative) on the ecosystem functionalities and metabolic cycles. All these phenomena are related to each other and new phenomena emerging from their interrelations have to be integrated into the knowledge and decision making process.

For example, some solutions became feasible thanks also to social inclusion problems and economic crisis, like the diffusions of urban food production (self-production) in the urban peripheries in last years.

6.1.2 Nexus and Rural Production

The Milano metropolitan area shows in a clear way the nexus between the water, the agricultural production and landscape and the urban development. The water system and the physical conformation of territory were preconditions and reasons for the development (and success) of Milan since the Renaissance. Integrated polices and planning solutions have to take in consideration the water cycle in the definition of urban renovation/development strategies and also in the infrastructure, public realm, environmental and agriculture sectorial polices.

The preservation of specific "open" surfaces able to offer better drainage performances is crucial to avoid a relevant increase of high flood risk (climate change) in metropolitan context. Territorial plans have to integrate environmental issues like water issues and rural and agricultural strategic vision in a long term vision.

6.1.3 Fragmentation and Vulnerability

A common conclusion emerges from different projects and experiences developed: the relationships between the level of fragmentation and the vulnerability of Peri-Urban areas. In order to describe landscape structure and to characterize landscape units, the main significant factors used are: landscape unit extension and shape, type of borders, presence of elements of disturbance, fragmentation. These factors are able to identify the vulnerability conditions of open areas in relation both to existing conditions and to transformation process and dynamics.

In particular, from the URMA Pilot[1] emerged that the fragmented Peri-Urban areas are also less involved in bottom up practices of "stewardship" or institutional process and polices aiming environmental/landscape safeguard or improvement. In the URMA Pilot the Peri-Urban systems were considered as a complex system in relation with other complex systems (urban, infrastructural, rural etc.) and specific factors were developed in order to understand and to describe the relationships between different components and patterns.

6.1.4 Governance

Main critical barriers to the implementation of projects and planning guidelines emerge in relation to the "governance" aspects, both to the "institutional" and "social/cultural" spheres. Existing governance framework is characterized by:

[1]Urban Rural Partnerships in Metropolitan Areas (URMA—http://www.urma-project.eu/) is an INTEERG IV C program (2012–2014). The Pilot Case developed by the Lombardy Region focuses on the Peri-Urban areas in the western portion of the Milan metropolitan area.

overlay of competencies, conflicts in the different sectorial laws/planning instruments, complexity in the administrative level of competencies, an explicit separation between the "urban land use" regulation and the agricultural regulation. Difficulties in the implementation of integrated projects are also due to the "cultural" conflicting relationships between city (urban or citizen) and famers. In recent decades a "new" trend has been clearly emerging in cultural and social spheres: alliances between citizen or urban communities and farmers are demonstrated by several bottom up projects, initiatives and partnerships. The need of an innovative approach to the governance process in order to valorize crosscutting initiatives and solutions and the multi-stakeholders process is clearly emerging.

6.2 Functions and Values of Peri-Urban Areas

Peri-Urban areas could be interpreted as a "transition zone" that can perform services and offer opportunities both to agricultural and urban systems. To identify these opportunities an integrated bio-regional perspective is necessary.

Based on literature and a number of main policies it has become possible to identify two main "services/functions" categories:

1_ Ecosystem (and environmental) services related to metabolic cycles (for example: water, carbon sequestration and climate regulation, ecosystems and biodiversity, the role of green infrastructures) (MEA 2005; TEEB literature: TEEB 2009; TEEB 2010; TEEB 2012; TEEB 2013; Naumann et al. 2011; E.C. Green Infrastructure 2013);

2_ Services to social and economic systems: Peri-Urban areas are eligible for the localization of market/distribution of local/regional food production (local food chains), services for farming production, services (start-up and hub) promoting innovation in agriculture productions.

In researches and projects developed a specific focus was dedicated to the implementation of Ecosystem services model at local level (in relation to the regional and local contexts in Lombardy and in the metropolitan area of Milan).

The Millennium Ecosystem Assessment (MEA 2005), has provided a structural classification of ecosystem services (ES): (1) support services: e.g. soil formation, photosynthesis, nutrient recycling; (2) procurement services: e.g. food, water, timber, fiber; (3) regulation services: e.g. climate stabilization, settles hydrogeological barrier to the spread of diseases, waste recycling, water quality; (4) cultural services: e.g. aesthetic values, recreational and spiritual.

Each ecosystem ensures a diversity of functions, and each service can be done by different ecological functions in turn performed by different ecosystems. From this follows the dependency link between healthy ecosystems as a whole and the quality and durability of ecological services. The services deriving from ecosystems are the direct or indirect result of ecological functions. Each landscape element can perform

one or more ES, but their quality depends on the quality level of the element itself, and also from the quality of the surrounding landscape (each landscape unit influences the quality of ES provided).

A relevant aspect emerged from the applications developed is that the identification (and also the assessment criteria) of ecosystem services have to be based on the principles and criteria of general ES model but they have to be improved and adapted in relation to local context.

The recognition and enhancement of ecosystem services and the improvement of green infrastructure can contribute to the reduction of pressures, contributing to increased resilience of territorial systems.

To reach an effective implementation of ES, a definition of the values of ecosystem services (cost of payment of ecosystem services) and governance instruments for (payment mechanisms) are necessary.

For each area can be recognized specific ecosystem services that could be performed (supported) through appropriate green infrastructure plan.

The territorial "areas" that have to be considered must be flexible (a variable geometry) because it has to include the sources of pressure, the different impacts on environmental and landscape systems and the "actors" potentially involved in the implementation/management (Fig. 6.1).

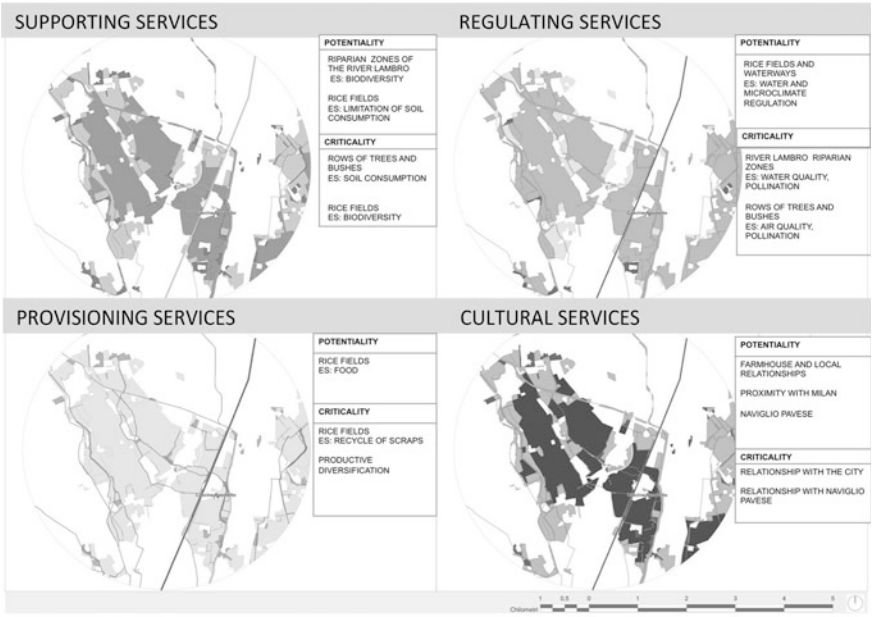

Fig. 6.1 Ecosystems services maps of land unit 1. The color scale is related with the importance of the elements for ES

6.3 Perspectives

As required by European guidelines, territorial development plans and programs have to include strategies/actions assigning to agriculture new roles related to territorial functions and services (e.g. environmental critical phenomenal reduction, services).

The most relevant principles and criteria towards the implementation of polices, programs and actions on Peri-Urban areas are: multiscale/multi-dimension in time and in space, flexibility and modularity, multifunctionality, multi stakeholders.

The identification of governance instruments able to support the implementation of urban-rural partnerships requires different efforts in terms of:

- Innovation of a planning system (in Lombardy): the actual framework of planning instruments is not able to support the (a) recognition of Peri-Urban areas as a planning category with specific characteristics and potentialities. (b) The planning and program system is not able to recognise the services and functions that are and could be performed by Peri-Urban areas (in particular the initiatives and services based on multi-stakeholders partnerships, e.g. local food chains);
- Agricultural system (and stakeholders) plays a central role in the ES implementation and this role (both in terms of guidelines and economical income) has to be recognized and managed. Territorial development plans could define polices in order to support a process of engagement of agricultural stakeholders;
- In relation to the Lombardy governance context, polices and goals are often conflicting (e.g. Soil consumption/externalization of environmental costs) a coordination of strategic goals is needed;
- A crosscutting approach and a process of re-alignment of the entire sectorial planning/program framework (e.g. water management program/rural development program, …) and the identification of specific crosscutting policies (supported by a financial program); a sectorial plan requires a proactive involvement of agriculture (soil defense plan, hydrogeological plan, landscape plan…);
- The pro-active involvement of the private sector (important to make explicit the economic advantages from urban-rural partnerships) and of local communities (citizens, associations and NGOs) during the entire process of design and implementation (definition of strategic vision, identification of services/functions, design of spatial solutions and/or planning solutions, implementation and management). The farming system could be active in the design, implementation and management of green infrastructures and ecosystem services (Emphasising on the economical innovation and economical source for rural enterprises);
- In relation to the social and economic trends and regional (and European) dynamics it is possible to identify in the “food chain and sustainable agricultural production” (based on agroecology approach) as strategic thematic asset for the implementation of a virtuous process of valorization of Peri-Urban areas.

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Chapter 7
The Nexus Services from a Territorial Perspective: Interactions and Trade Offs

Giulia Pesaro

Abstract The aim of this essay is to introduce the potentials of a territorial based approach to support decision-making regarding the uses of land in order to optimize the value production and the ratio between exploitation of resources, supply of water, energy and food services (WEFS) and preservation of the natural environment. Land and the natural resources integrated in it are regarded as the physical reference units of the WEFS in a nexus perspective. From the one side, land is the complex system of resources, material and natural ones in particular, which sustain WEFS security and quality in terms of production and consumption models. From the other side, the production of WEFS demands for *production surfaces* which represent the field where different uses and use models meet and produce cross impacts and trade-offs. The land quality, availability and, mainly, model of use become crucial factors to guarantee a stable and adequate offer of WEFS. This in the light of a growing demand for the protection of the natural environments and the ecosystems and for enhancing the quality of social services, in a perspective of resilience and sustainability. Finally, a brief presentation of a case study will be proposed, regarding the story of the Lago d'Idro (Idro Lake). Here the conflicts on water uses go back to the starting of the twentieth-century: a good example of the interactions, tradeoffs and decision making around the sharing of water among different territorial uses and users over time, in presence of a growing scarcity caused by long periods of drought at the local level.

7.1 An Approach to the NEXUS Services Analysis and Decision-Making

The central importance of the nexus approach deals with the conditions under which a system can, and can continue over time, to supply the water, energy and food (WEF) required to fill the needs expressed by a community (SEI 2011). Following an economic thinking and perspective, such needs represent the demand for WEF and

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the related uses, depending on the characteristics of the local production and consumption model. The other side is the supply, which depends not only on the capability itself (conditioned by a certain state of technology) to produce WEF services (WEFS) but also on the natural cycles regulating the regeneration of resources and the waste recycle and assimilation at the end of the production and consumption cycles (Ringler et al. 2013). On the one hand, the availability, quality and productivity of water, energy and food resources vary enormously among regions and production systems, according to geographic position, climate, geomorphology, land physical composition and other natural factors. On the other hand, the intensity of use and the demand of WEF and WEF services is increasing and there is a tendency to converge to similar consumption models at the world level, especially in developed and in-transition countries.

The aggregate pressures produced by the human settlements and activities are related to multiple uses for a variety of purposes and generate trade-offs and conflicts, especially when an increasing demand generates scarcity and environmental and social impacts (externalities). A framework which becomes even more complex when adding the growing demand for the preservation of natural resources for both their absolute value (as addressed in the environmental economics literature) and their contribution to the production of services and activities based on the natural environment quality, from the ecosystem services to economic activities like tourism and leisure.

From an economic perspective, to assure WEFS security means to consider a problem of production optimization and productivity maximization where fundamental values for humans and the natural environment are contemporary at stake. As the physical elements are central in defining the potentials of the WEFS production and balance, together with the specific characteristics of the resources exploitation model, an economic and territorial based approach seems useful, where land, with the natural resources integrated in it, represent the *physical reference unit* of the WEFS and their nexus. Land is the complex system of resources, material and environmental in particular, which sustain WEFS security and quality in terms of production and consumption models. The production of WEFS demands for *production surfaces* whose quality and availability becomes a crucial resource to guarantee a stable and adequate offer. Land, also in terms of a specific territorial area, should therefore become the basic physical reference and nexus analysis unit for WEFS and the reference element to evaluate the balance among the demand and the capability of a certain territorial to supply what needed.

7.2 Land and Territorial Spaces as the WEFS Nexus Reference Unit

Each land or territorial reference unit is characterized by a certain natural equilibrium, a system of ecosystem services and interactions identified by the nexus approach. It guarantees the renewal of resources and the duration of the system over

time. The same space is a production surface, subject to a multiplicity of demands for uses, coming from a variety of subjects, often referring to a huger territorial system than the visible production territorial area. The different uses, when overcoming the withdrawal or use amount that allows the system to maintain its equilibrium, interfere with each other and give birth to conflicts. A dynamic environment that becomes even more challenging for decision-makers when the final users are far away from the production area (which happens more and more often in highly developed and urbanized areas). The enlarging of the reference area for the WEFS production amplifies the impacts of the distance between decision making (supply and consumption models) and the territorial productive unit. The farther the decision maker is from the physical land unit, the more difficult it is to optimize the whole system of uses, in a framework often characterized by competition for the access to scarce resources from a multiplicity of stakeholders, at different territorial scales over time.

In such a framework, the general challenge of policy makers, especially when seeking for sustainable development at the land level, is to create the conditions under which multiple stakeholders reconcile their competing claims and interests through negotiated trade-offs of land functions. This at the correct land and territorial scale and over time. The more the number of stakeholders and users increases, together with the number and variety of uses (also due to the development of the life style of communities and the rising of the awareness of the values of ecosystem services), the more the potential conflicts rise in number and complexity. Space matters because: (i) of the intersections, interactions and trade-offs to be identified and addressed by decision-makers; (ii) of the supply and demand models; (iii) of the decision making process itself, with the related goal setting. All these elements of course matter with the land physic, geomorphologic and natural specificities, existing uses and use functions. Time scales refer to: (i) the dynamics of WEF resources production and renewal; (ii) the relationship between the time of production and renewal and the dynamics of the WEF products and services demand; (iii) the capability to figure forecasts and scenarios for the future.

7.3 An Example of Nexus Interactions and Trade-off at the Territorial Level: Conflicts in the Use of Water Resources of the Idro Lake

The Idro Lake is a little alpine lake in Northern Italy, with a water reservoir of 11 km^2. It is part of the hydrographic basin of the river Chiese, whose 934 km^2 surface splits in three provinces of the Lombardy Region (Brescia, Trento and Mantova). It represents a case of great interest looking at the WEFS nexus as a *water war* (Pesaro 1997) among uses and users started in the early 1900s and is still open. Over time, the number and variety of uses and stakeholders has increased. In the 1910s begins the construction of an artificial basin upstream the lake as an

answer to the new demand for electric energy at the local and over local level. Than a dam (still in use) was built in the 1920s downstream, to convey water to the fields around the Chiese basin and to the industrial activities rising in the area. Such hydraulic infrastructures, regulating both the inflows and the outflows, modified the environment and limited the natural dynamics. Since then, the lake has ever been experiencing conflicts among competitive uses, to definitely become a multi-stakeholder and multi-field *conflict arena*, involving agriculture, energy, industry, tourism, leisure and ecosystem services. In 1987 the local communities began a public opposition to the main holders of the rights on water uses in front of the National Public Waters Court (Tribunale superiore delle acque pubbliche). The main reason was the excess in the water levels change range. The shores of the lake, mainly in summer, where enlarging more than 7 m due to the excess in agriculture and hydroelectric power withdrawals. These dynamics were greatly affecting both the natural environment and the tourism and leisure attractiveness of the area. The landscape, the access to the lake waters and the fishing activities were damaged, together with the capability itself of the ecosystem to live and renew, even if the lake had been recognized as a Site of Community Importance in 1990. The uses of water with consumption, for food, energy and industrial manufacture purposes, conflict with each other at a large territorial scale, with some decision-making centers far away from the Idro lake territorial reference (energy producers for instance). Moreover, other uses and stakeholders at the local scale come into play over time, which are mainly interested in the conservation of water in the basin and in the protection of the natural equilibrium of the Chiese river basin. The demand for the conservation of an adequate water quality and quantity is related to the ecosystem services production, the safeguard of the specific fauna and flora of the lake and the safeguard of the economic activities related to the summer season tourism, fishing, sports and leisure.

Starting from the early 1990s there is a shift in the public perspective and the State starts an experimentation phase to decide how to share the water resources among this complex system of competitive uses and, over time, how to make uses more environmentally sound. A change in perspective was also driven by the increasing capability of the local administration bodies and the civil society to identify and directly defend their instances and to increase their weight in public-decision arenas. The activities by the riparian municipalities, various local authorities and associations of citizen never stopped from that period on. Over time, the demand for a drastic change in the water use models and in the behaviors of the public and economic subjects has become more and more passionate. In 2006 the Local Committee for the Protection of the Idro Lake and the Chiese River Basin opens a website and begins to publish an official information sheet to better influence public opinion and make pressures on the public bodies at the regional and national levels. They succeeded in arriving to a hearing at the Parliament the same year and, in 2012, in obtaining some degrees of protection about the water levels in the lake and the related quality.

An important step is still missing for the development of a more stable and adequate decision-making framework for regulating the uses of the water and of the

whole of the basin resources. A serious and updated analysis of the supply side, the natural water and ecosystem cycle at the local scale, and of the demand side, the model of the whole of the uses and users that characterizes the basin at the local and over local levels. This carefully considers the needs for consumptions and for conservation of water and the related production of value added.

7.4 Conclusions

From the above discussion, some main elements arise. First, decision-making about the sharing of the WEFS resources among uses and users implies a choice among alternatives. The utility of enhancing knowledge about the system of reference values, cost and benefits, cross impacts, nexus and externalities connected to the specific characteristics of a territorial system and the related WEFS systems is evident. The challenge is to understand how to optimize/maximize the overall value produced, taking into consideration sustainability and resilience of territorial systems. This requires adequate analysis, regulation and planning at the local and over local scales, as the WEFS demand and supply, in modern complex territorial systems, depend on a variety of centralized and specific decisions and behaviors. WEFS security remains a central issue (SEI 2011) but should necessarily be coupled with a systemic view, instances of territorial and environmental sustainability and the building of a resilient WEFS supply systems (Hussey and Pittock 2012) at the *right territorial level*. The challenge is the building of a toolbox for promoting a sustainable, durable and resilient WEFS system taking into consideration the whole of the nexus implications at different land and territorial scales, taking land as the main reference physical unit. Local physical specificities, demand for land uses, territorial scales concerned in production and consumption (interactions and externalities) at different time thresholds should be considered, aware of the fact that decision-making needs to be addressed by good knowledge on both the local and over local scales dynamics. Finally, the assumption of a clear economic perspective may also contribute in assigning more appropriate values to natural resources and the commons and better integrate them into the model. The availability of a shared and adequate assessment model may then support the building of better forecasts and scenarios supporting the development of sustainable and resilient WEFS for territorial and social quality improvements.

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Part II
Planning the "FEW" Nexus: Cases and Applications

Chapter 8
Flood Risk Management and the Nexus Approach: A Preliminary Conceptual Overview Based on Case Studies

Scira Menoni

Abstract In this article we will focus on the relevance of the nexus concept in the case of floods, with the aim of understanding what role water, food production and energy play in flood events, both in terms of potential driver of the risk itself and in terms of potentially affected systems. Water, energy and agriculture will be analysed as both potentially vulnerable targets and drivers of the flood hazard. In the final part of the chapter some general reflections related to the Nexus approach in general and its specific application in the Peri-Urban context to deal in particular with flood risk will be developed.

8.1 Introduction

In this article we will focus on the relevance of the nexus concept in the case of floods, with the aim of understanding what role water, food and energy play in flood events, both in terms of potential driver of the risk itself and as potentially affected systems. Coherently with this perspective, the article's sections are organized as follows: first the linkages between energy, food and water with flood risk and flood risk management will be described. In the last section more general considerations will be made regarding the relevance of the nexus approach in managing flood risk and the need for introducing more convincingly land use, spatial and urban planning as fundamental components of non-structural mitigation. Examples that will be provided in the first three sections derive from empirical observations carried out in the Umbria Region, thanks to the collaboration established between researchers at the Politecnico di Milano and the Regional Civil Protection Authority (see Molinari et al. 2014; Ballio et al. 2015). Umbria is a small region in Central Italy with a population of around 900,000 people. Both riverine and mountain floods occurred in particular in November 2012 and November 2013

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in the Umbria Region, that provoked a total damage of about 150 Million Euros to different sectors, including energy, water lifelines, and agriculture.

8.2 Some Considerations on the Nexus Between Flood Risk and the Energy Sector

Energy production sites and distribution networks are exposed assets that may be affected by floods. Despite of the call for more resilient networks (EU Directive on Critical Infrastructures Protection, the Sendai Framework for Action (see UN 2015); the World Bank, 2012), the challenges to make critical facilities keep functioning and to provide basic services after extreme events is largely under reported, with few exceptions (Pitt Report 2008; Ministère de l'Écologie et du Développement Durable 2005).

In the Umbria case, we were able to get relevant information after the 2012 November flood on damage to the power sector tracking down incoming calls regarding outages and aid requests from power managing companies arriving at the emergency operational center. The number of households deprived of electricity and duration of outages (ranging between a few hours to two days) are represented in the map in Fig. 8.1. Furthermore, we had access to the internal report of the electrical company that intervened mainly in the city of Orvieto, where mostly the industrial area was affected. Transformation cabins and main lines were submerged by the flooding water, so that generators were needed for long time and full restoration including lines and cabins relocation took almost a year.

The energy sector, though, is not only a potential "victim" of the flood. As put in the Technical Report 2009-040 on the "Common Implementation Strategy of the Water Framework Directive 2000/60/EC", «existing dams can also contribute to flood risk management. Dams and reservoirs, if properly managed, can be considered as an important part of integrated water management schemes under climate change conditions. Such dams are subject to operation licenses for hydropower schemes in which the regulating national authorities establish the conditions under which a power plant shall be operated […]. This license/permit contains detailed conditions for river flow regimes and minimum and maximum water levels to respect according to the season, so that for example enough storage space is in the reservoir to absorb the spring flood. The way water flows are regulated in such rivers should take potential changed flood patterns into account, to make sure flood risk isn't increased, but rather decreased in the way the flow is managed». The role of dams in flood management has been set in Italy in the "Operational guidelines for the intervention of the Civil Protection in catchments where large dams are located", issued in 2014 by the Presidency of the Ministries Council. Previously a non-mandatory document of the Civil Protection Department was considered as a reference since 1996.

The Directive states that dams managing companies must cooperate with civil protection authorities whenever a flood alert is given (according to the National

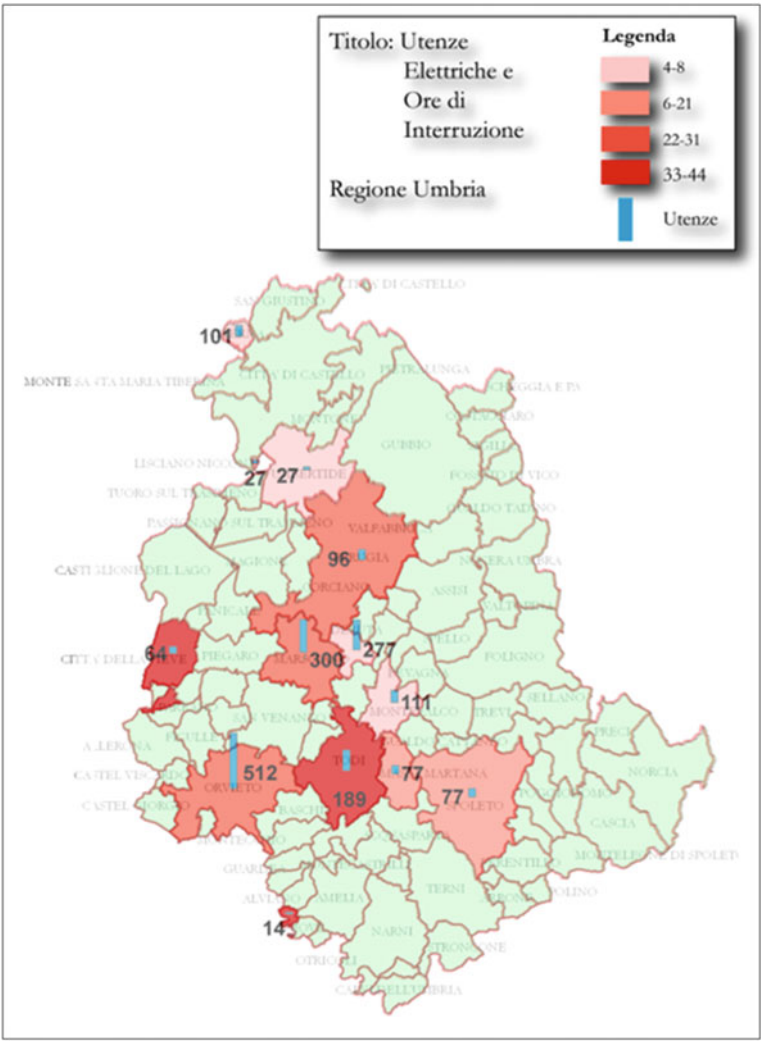

Fig. 8.1 Municipalities where power outage was reported and its relative duration

Civil Protection Directive on early warning issued in 2004) and have to release quantities of water in advance of the forecasted rainfall so as to retain expected volume peaks.

In the Umbria Region a "Dams' retention capacity plan" was in force before the formal approval of the 2014 Directive and played a crucial role in reducing the impact of floods. The implementation of the plan in November 2012 and November 2013 avoided the escalation into much more catastrophic scenarios (Berni et al. 2013). In particular, in the 2012 event the Montedoglio dam permitted to store 25 Million m^3 of water, the Corbara dam 75 Million m^3 out of the 250 m^3 that flew

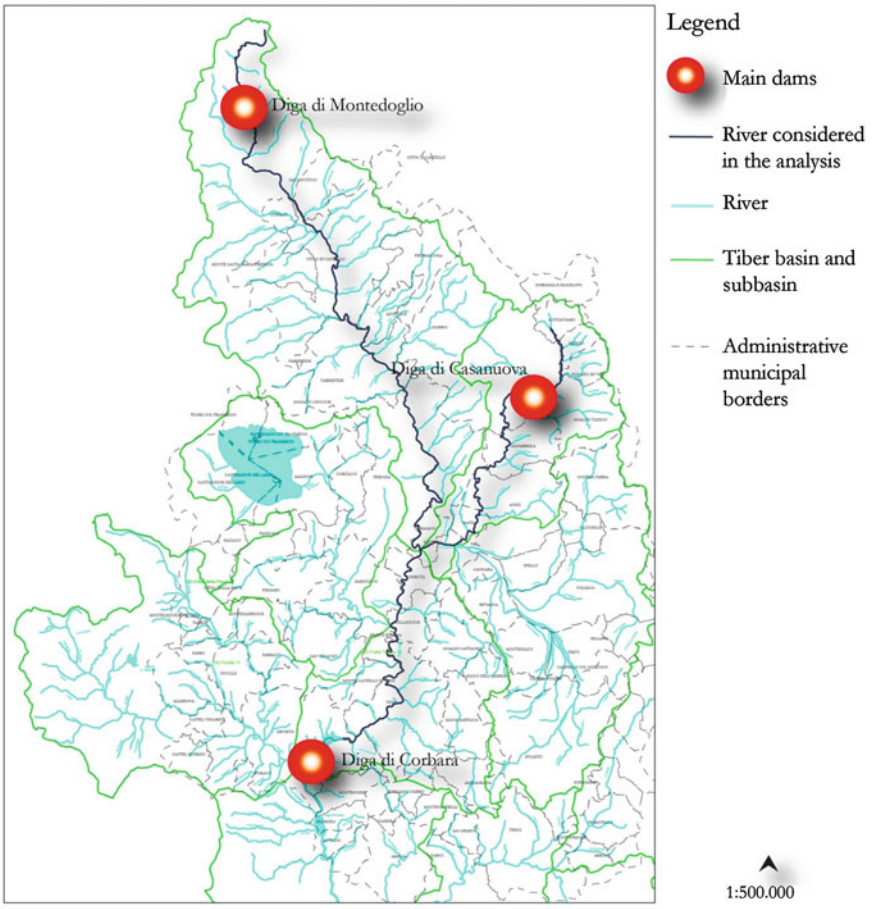

Fig. 8.2 Map representing the location of the major dams whose basins were used as retaining emergency catchment areas

through the dam to the Paglia tributary of the Tiber River. In the 2013 event, the Montedoglio dam retained 25 Million m^3 while the Corbara dam 70 Million m^3 thanks to the rainfall and hydrologic forecast 36 h ahead of the actual peak (Fig. 8.2).

8.3 Interaction Between Agriculture and Floods

In recent years there has been growing attention to the damage suffered by the agricultural sector during floods. Brémond et al. published in (2013) a useful review of the existing literature, pointing at the various obstacles in developing flood

damage curves for the agricultural sector. Flood damage functions are used to correlate flood hazard indicators (water depth more frequently, but also water velocity, presence of sediments, duration of the flood that is very relevant to establish damage to cultivations and soils) with damage (as damage index or monetary cost of recovery/cost of lost production). In his review, Bremond shows that under the label "damage to the agricultural sector" different types of affected items have to be considered. Those include: lost crops and yield reduction, damage to the perennial plant material (like vineyard or orchard), damage to soil structure (due for example to salinization or contamination), damage to machinery, stocks of products, buildings used for agricultural activities. Each of those items actually require a set of functions, as different indicators of vulnerability need to be considered.

Coherently with the European legislation, in Italy the agricultural sector is subject to semi-mandatory insurance policy available at subsidized premiums. Requests of compensations can be compiled only if a declaration of "exceptional meteorological event" is issued by the Ministry for Agriculture. Such declaration covers under the same label phenomena that are different in severity and geographic coverage, such as floods, extreme winds, hail or storms and is only loosely related to the declaration of the state of emergency decided by the Presidency of Ministries Council under the technical reporting prepared by the National Civil Protection Department (see Mysiak et al. 2013).

This separation of powers and institutional competences did not help much in getting detailed data related to the 2012 flood in Umbria in 2012. 12 Million Euros damage was reported after the November 2012 flood but further breakdown is not possible. For the 2013 event, that provoked a much less severe damage of 3.8 Million Euros, detailed data could be obtained through declarations made to municipal authorities. Structures, internal fields infrastructures, crops, stocked materials and machinery were all damaged either by flooding water or by landslides. In one case a field was covered by the debris carried by the mountain flood and which covered the entire property. In another case, fields were contaminated by sewerage waters leaking from damaged pipes.

Reflecting on the relationship between floods and agriculture, the role of the latter as a risk driver should not be dismissed either. In their article, Wheater and Evans (2009) point at the role of certain types of agricultural land uses and practices in increasing the flood hazard in the UK in the last decades. They point in particular at «the loss of hedgerows and increase in field size, the installation of land drains connecting hilltop to river channel, and channelized rivers with no riparian zones». However, as discussed by the Authors, it is by no mean simple to understand how those practices have contributed to increased risk of large floods at both the catchment and the local scales.

8.4 Floods and Water Quality Management in Europe: The Interplay Between the Floods and Water Directives

Ironically, after a flood there is a shortage of water for hygiene and drinking usages. The reason is quite simple: the flood overwhelms the storage and discharge capacity of pipes, treatment and purification plants so that uncontrolled sewage waters are spread around contaminating also drinking water (Veldhuis et al. 2010). More severe contamination effects result from the flooding of industrial sites. In general, those episodes are contained in short time, however high costs are associated with the recovery of the clean water system and the repair of damaged pipes and sewerage. In the case of the Umbria flood in 2012, water treatment plants were damaged in the most affected municipalities of Orvieto, Todi, and Marsciano in the North-Western part of the Region, requiring a public expenditure of almost 1,200,000 Euros for repairs (out of the 56 Million that were compensated overall by the Government for this event). Even though no Seveso installation is located in the Orvieto industrial area, still existing factories, including mechanical firms, car garages, paint shops, oil stations, provoked water contamination and released a rather large volume of waste that was carried downstream by the Paglia river.

The 2013 event was associated with damage to sewerage plants and systems too, totaling around 1.8 Million Euros (out of the 88 Million that were declared as damage to the Government), mainly due to landslides destroying parts of conducts in the North-Eastern municipality of Costacciaro.

Going beyond single flooding incidents, a more general concern has been recently expressed by European institutions regarding to the need of connecting more tightly legislation to protect water quality in rivers and measures aimed at mitigating flood risk. The Water Framework Directive (2000/60/EC) addressed the need of preserving clean water storage, decontaminating rivers' waters and restoring as much as possible the natural ambience of riverbanks. The Water Framework Directive also listed protection from extreme floods as a key environmental objective. The Flood Directive (2007/60/EC) is focusing exclusively on flood risk, prescribing a risk assessment and management system for European catchments, both national and transboundary. Still, the Flood Directive places prevention of damage to natural environments as a priority, together with people at risk, cultural heritage, and economic activities.

8.5 Wrapping up: How the Nexus Relevant in Flood Risk Governance?

The nexus has been presented as a useful conceptual framework focusing on multi-level and multi-dimensional connections between food, energy, and water (Bazilian et al. 2011). Some authors consider the nexus as a mode of looking at the

interactions among natural and social systems that should lead to a broader understanding of the systemic links between all systems (Bhaduri et al. 2015). Following the nexus framework would lead to link risk mitigation to sustainability and to pursue a systemic approach to risk and environmental management. The systemic approach is not new, but due to the complexity of both natural and artificial systems, priorities regarding the "key" systems and links among them to be tackled first must be established. This is a choice that is inevitably biased with respect to whom is conducting the analysis, the time when the analysis is carried out, but also the spatial scale that is considered.

The second aspect that is evidenced by those endorsing the nexus approach is the fundamental link between sustainability, risk prevention and climate change mitigation and adaptation, particularly when hazards such as floods having a strong meteorological driver are considered. Making space for the river, reconnecting the floodplain with the river, renaturalizing urban ambits, particularly in Peri-Urban areas are all mitigation measures that have been the focus of recent debate and even policies (see for example The Netherlands). Even though considered as welcomable, those practices do not come without a cost. Issues of equal distribution of costs and benefits among those who will sacrifice economic advantage and in some cases will have to relocate somewhere else and those who will benefit from the reduced flood risk and from recreational uses more compatible with flood risk, cannot be neglected (Warner et al. 2013).

When it comes to renaturalization, the issue is even more tricky: in fact this practice recalls the preservation approach in landscape and cultural heritage, suggesting the same problematic need to define to what period or type of natural environment one wants to bring the system back to. Natural settings do not necessarily lead to a less hazardous condition. As discussed, Wheater and Evans' (2009) significant advancement in modelling capacity needs to be made to demonstrate what type of land use is actually providing more safety than others and that clearly not just any vegetation coverage is advisable to reduce the flood potential.

8.5.1 The Nexus Approach to Risk Governance: The Role of Land Use and Spatial Planning

Finally, we would like to address a couple of issues that are specific to land use, spatial, and urban planning perspectives.

First the scale at which plans and mitigation measures are designed. Urban planners pay attention to the re-naturalization or nature-based solutions to be pursued in particular in Peri-Urban areas, that still offer the possibility to re-design the urban landscape. Planners need to face multiple challenges as needed: to recognize and act on the links among vulnerabilities emerging at different spatial scales; forecast the impact of local interventions on the larger catchment; and in the

meantime assess how some critical catchment's characteristics may influence the evolution of potentially dangerous scenarios in places where they intervene. Failure to do so implies investments that prove to be much less effective than originally thought of or even counterproductive.

Second, planners need to understand how protection and risk are intermixed in any type of intervention and be more aware of the need to create connections with other types of mitigation measures such as for example emergency planning. Where and how development and transformation of existing settlements will take place has important repercussions on how emergencies and crises will be managed. On the other side, also emergency managers need to become more sensitive to the environmental sustainability of their practices while responding to a disaster. Labadie (2007) takes an interesting stand being an emergency manager, when he stresses the need for rapid environmental assessments as part of disaster damage assessment to become part of reconstruction and mitigation decisions.

8.6 Final Consideration

When the nexus approach is adopted to design strategies aimed at comprehensive management of rivers safety and ecosystems preservation or restoration, to achieve both water quality and protection from extremes such as droughts and floods, a wider literature made of reports and comment notes in independent journals has to be considered (International Institute for Sustainable Development 2013; Groenfeldt 2010). On the one hand, because the scientific literature in peer reviewed journals seem to be stepping behind what is occurring in conferences and initiatives led by international and national organizations.

On the other, the lack of scientific literature on the topic is also the result of the objective difficulties to provide scientific evidence of the nexus approach beyond general statements or partial identification of verifiable links as we did in the first sections of this paper. Di Silvio (2015) suggests that when a more "holistic" perspective has to be taken, «the gap between academics and professional practitioners, as well as between researchers with a physics based and a more environmentally based education, needs somehow to be bridged by appropriate models that combine a certain "universal" predictive capability (via determistic equations) with an appropriate amount of "site specific" data (based on empirical observations)».

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Chapter 9
Nexus and Disaster Prevention: What Can We Learn from the Genevan Urban Area?

Patrick Pigeon

Abstract The nexus concept has been applied in the Canton of Geneva since the early 1950s maintaining an agricultural belt for the city that was aimed in the meantime to sustain the city with locally produced food, to provide geothermal energy, and to safeguard it from floods. The article discusses the many contradictions of such nexus approach when the latter is adopted at the local level, neglecting the many loops and feedbacks that need to be considered at multiple scales. Specifically, in the case of Geneva, the green belt policy transferred the urbanization process upstream across the French border. This process unwillingly increased flood-risk disasters for the Swiss part of Geneva itself, and can be understood as an unwanted feedback loop. Even more, the 2002 Swiss disaster in Lully had also unwillingly been prepared by the local nexus unwanted side effects. Therefore, the need for a more comprehensive, integrated and multilevel approach while considering the nexus is discussed. In this case, the nexus helps illustrating and discussing what resilience could be.

9.1 Introduction

Why do we refer to the nexus while understanding and managing water related disasters, and specifically as regards Geneva? The nexus defines the need to clarify interactions and coevolutions between various functions, institutions and stakeholders responsible for disaster risk reduction policies.

The Genevan agricultural and green belt reveals the political wish to address at the same time various issues related with agriculture, water and energy. It was meant also for preventing floods, because of its linkages with water retention basins

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and aquifer management. However, while managing the nexus at the local scale, Genevan policies unwillingly contributed to transform Peri-Urban environments at a wider scale across the border, in France, preparing for future disasters. Regional feedback loops have been already investigated by research on green belts (Sorensen and Okata 2011). The findings that will be discussed in the paper suggest that the nexus approach shares with strategies aiming at resilience. It acknowledges the need to live with uncertainties, related to the impossibility to anticipate entirely the outcomes of given policies (Godard et al. 2002).[1] It also displays the limitations of quantification. Nexus also fits the contradictions embedded in resilience as pointed out by various authors (Walker and Salt 2006; Cummings 2011; Pigeon 2012). Indeed, resilience targets maintaining the fundamental structures of the socio-ecological systems concerned by the damaging events. Yet, at the very same time, it contributes preparing future disasters. Understanding these contradictions, that emerge also in the Geneva application of the nexus approach, requires to be aware of the interactions between systems at various scales and on various time spans, that's to say, complexity (Gunderson and Holling 2002).

9.2 What Does the Nexus Mean? What Has It to Do with Disaster Prevention?

The notion of nexus has also been used in the field of international political sciences, in relation with knowledge management. According to Chandler (2007), the notion dates back to the beginning of the 21th century, in order to draw attention on the gaps between policies and their implementation. In order to reduce these gaps, "The security–development nexus has become the fashionable way of describing the linking of security and development concerns over the last 10 years (p. 365)". Therefore, the nexus "looks into the production of knowledge aimed at increasing coherence between domains of security and development" (Steputtat 2012). And it also aims at reducing the "incoherent proliferation of actors and policy perspectives" (Chandler 2007).

Therefore, this notion of nexus is consistent with the trend towards promoting knowledge management systems, as is the case in the realm of disaster prevention (Renaud et al. 2013; UNISDR 2013, see also the recently concluded project Know-4-drr[2]), to reduce the gap between knowledge, policies and policies implementation, hoping to contribute more to disaster prevention.

[1] «Incapacité à déterminer une liste complète de résultats possibles de l'action» (Godard et al. 2002, p. 38).

[2] http://www.know4drr.polimi.it/.

9.3 How to Justify the Nexus Transfer to Peri-Urban Areas?

According to Pesaro (2014, and in this volume), the nexus helps "underlining interactions, tradeoffs and conflicts" between various functions devoted to Peri-Urban areas. It is a concept that may help finding solutions to discrepancies between policies and implementations, as well as to better manage problems set by current prevention policies that imply an increasingly larger number of stakeholders. Understanding conflicts and disaster prevention limitations implies taking into account open space land-use belonging to Peri-Urban areas, and justifies turning to the notion of nexus (Knieling et al. 2014). Therefore, following Pesaro (2014, and in this volume), "nexus physical reference unit is land", or territory if we consider the issue as a geographer. It's not possible to make sense of conflicts and contradictions found during field surveys without referring to trade-off between the wide range of stakeholders involved in disaster risk reduction and land use policies (Subra 2007). Such is the case with space for the river policies as they have been implemented in France (Pigeon 2013). They do not concern flood disaster prevention only, and this is precisely why the notion of nexus does make sense.

9.4 The Nexus in Geneva: The Multifunctional Agricultural Belt Preventing Disasters at the Local Scale

How does the nexus look like in Geneva? The answer is an official one, since the agricultural belt has been recognized as a means to provide water, energy and food for local needs, at the Canton scale. Such multifunctionality is acknowledged since the 1929, confirmed in the 1953 Master Plan (Fig. 9.1), and again in the much more recent Plan Directeur Cantonal 2030 (Plan directeur cantonal 2013).[3] A bit more than 50 % of the total surface of this Canton is devoted to agriculture, and the built-up area does not exceed 25 % of the total amount. It contributes to explain the sky-rocketing land values this small Swiss canton experiences (Pigeon 2011).

Indeed, this agricultural belt does not provide only food. It contributes to protect local aquifers from built-up areas. The southern part of the Canton is concerned by the "Genevan" aquifer which bears "Genevan groundwater". «About 20 % of the total amount of water provided for drinking by the Services Industriels de Genève is taken from the "Genevan groundwater"» (SPAGE Lac-Rhône-Arve 2014, p. 39).

At the same time, the potential for geothermal energy production of the aquifers has been also officially recognized. The areas allowing geothermal exploitation fit, at least in part, those still devoted to agriculture today. Lastly, some of these areas

[3] http://ge.ch/amenagement/plan-directeur-cantonal-2030.

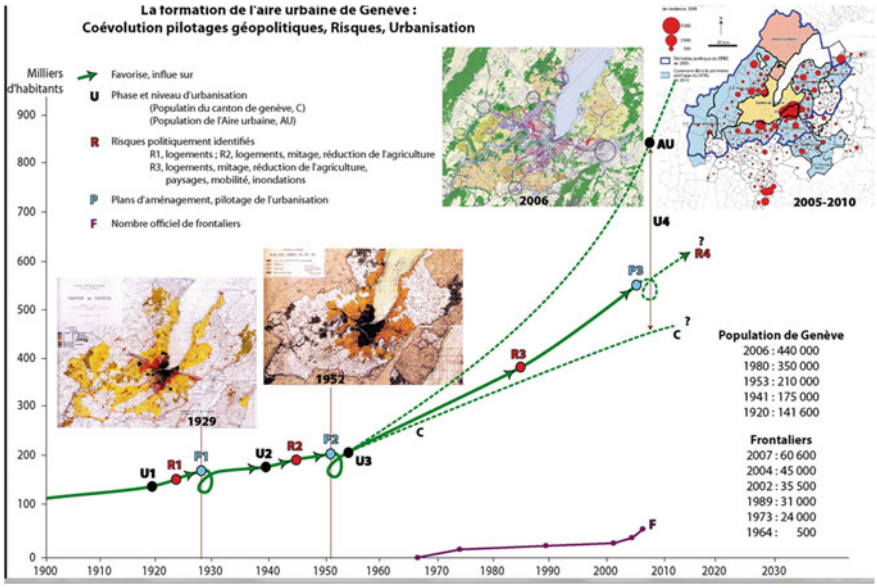

Fig. 9.1 The nexus in Geneva and its limitations: impossible to get rid of risks in spite of the existing "agricultural belt" (Pigeon 2011)

play the role of flood extension basins. Such is the case for rivers Arve and Aire in the agricultural part of their watershed.

Let's mention the fact that these various uses are mapped on the official Genevan geographical information system (GIS). The information can be found back rather easily on the web (at the site: http://ge.ch/geoportail/pro/). Crisscrossing information layers reveals contradictions and conflicts between these land uses, which is consistent with the notion of nexus. For example, geothermal potential of surficial groundwater under the surface of river Aire floodplain conflicts with the need to protect the quality of Genevan groundwater. This groundwater belongs to the aquifer named "alluvion ancienne", which is found deeper, and which dates back to the interglacial period between Würm and Riss. Exploiting the geothermal potential requires boring, that would weaken the protective layer between the two aquifers. Therefore, exploiting geothermal potential of the surface aquifer is restricted, and, in some areas officially mapped, even forbidden. The quality of river Aire water is also impacted by agricultural activities and occasionally also by floods when the Aire floodplain plays the role of flood-expansion basin (November and Reynard 2006).

In spite of these contradictions which the Genevan GIS allows one to display, at least in part, and helps to manage, the Genevan nexus could give the impression that risks are being controlled, if not on the way to be eliminated. Yet, as usual, experience returns prove that such an expected outcome cannot be reached.

The nexus helps managing and reducing land-use conflicts and flood-related damages intensities to a certain extent, but it contributes to transform them as well, at the regional scale but also at the local scale.

9.5 The Nexus in Geneva Demands Managing Risks at the Regional Scale

Indeed, Genevan policies targeting to maintain the local, Swiss agricultural belt, forming a local nexus, contributed to transfer urbanization to neighbouring areas, such as those belonging to French Haute-Savoie. Once again, Swiss archives prove that this trend has been officially recognized, at least since the Forties (Pigeon 2011). Figure 9.1 traces back various stages during which Swiss official land-use policies increased this urbanization transfer, especially after the 1953 Master plan.

But this transfer concerned French municipalities, some of them belonging to the same watersheds as Swiss Genevan ones. Such is the case with the Swiss-French Foron which flows alongside the border between the two countries. Upstream, the French part of the Foron watershed was affected by the urbanization transfer compensating for stronger Swiss land-use regulations, that pushed French local municipalities to gain ground close to the mountain rivers. New buildings and streets appeared on these newly reclaimed areas, increasing vulnerability and damages experienced during floods. In turn, these events pushed local authorities to transform river beds even more. Local archives, municipal as well as "départementales", allow tracing back the process, which take the shape of positive retroactive loops as follows: more damages, more corrective works, more buildings, which lead back to increased damages intensities, and more corrective works. During field surveys, we find back the polychronic and heterogeneous pattern of corrective works, such as dikes and sills, which is consistent with the information coming from the archives.

Yet, this trend did not concern the French side of Foron watershed belonging to Genevan Peri-Urban area only. Upstream, corrective works reduced the amount of sediments transferred downstream and contributed to increase the energy the river dissipates on the wet section of its bed. This provoked in its turn the weakening of the dikes erected to reduce the floods' frequency on the Swiss part of the watershed. Local Swiss hazard maps, named "cartes de danger", take this trend into account and integrate it into flood risk zones. They were used by Swiss stakeholders as a means to oppose the cantonal wish to develop a new urban node, in accordance with the 2006 Genevan land-use management plan, on the area named Communaux d'Ambilly-Mon Idée (Pigeon 2011, Fig. 9.1).

In addition, downstream, near the confluence of river Foron with river Arve, exactly where dikes have been more weakened, a waste-water treatment plant lies in a flood-prone area. The quality of the river Arve, that feeds the Genevan aquifer, depends, even in part, on this waste-water treatment plant (SPAGE Lac-Rhône-Arve 2014).

What we find here can be named unwanted feed-back loops, at the regional scale. While hoping to escape flood-related disasters, and to maintain the agricultural belt which contributes at least in part to fulfil that goal, Genevan State favoured the emergence of new situations, of course, unexpected and unwanted. These situations are disaster prone. The nexus cannot work at the local scale only and requires instead having more partners around the table during land-use policies negotiations. In the Geneva case, it demands developing international, Swiss-French relationships (Fig. 9.1).

9.6 The Nexus in Geneva Unwillingly Contributed to Prepare for the 2002 Disaster

On the 15th of Nov. 2002, more than 500 people were reported affected by a flood impacting the hamlet of Lully, which belongs to the municipality of Bernex in the Swiss part of the catchment. The number of people affected and the need to turn to external help to cope with the damage meet two of the three criterion CRED (2014) uses for defining a disaster.

How to understand that this disaster occurred, in spite of the existing local nexus, thanks to which the agricultural land has been left free from urbanization to act as a retaining basin?

First, the affected area has been built indeed in the floodplain; second, the flood was not provoked by the Aire itself as existing dikes did not break and/or were not overwhelmed during the event (November and Reynard 2006; Rapport du Conseil d'Etat au Grand Conseil, M 1572-A 2004; SPAGE Aire-Drize 2010).

One of the main elements explaining the disaster appears on the official Genevan GIS itself. It depicts very clearly the convergence of agricultural drains towards the built-on and 2002 flooded area (red shape).

Technical reports indicated the existing surficial aquifer and its relationships with river Aire as the main causes of the flood (Tanquerel 2003). Upstream from the flooded area, water drained from the surficial aquifer could not be transferred to Aire river. In Fig. 9.2 the flooding mechanism has been represented: the flooded zone is depicted in red. The red bold lines represent major agricultural drains, which converge towards the 2002 flooded area. The grey light lines depict the hydraulic-head isopleths, lines joining the medium values where the level of water table should be found in the aquifer, and they concern the surficial aquifer. Below this aquifer, we find a protective layer, and the Genevan aquifer, but the information available has not been reported here.

In fact, the level of water rose very rapidly in the aquifer, not allowing the drains to work properly and water was unwillingly conveyed downwards to the built-on areas where some of the major agricultural drains meet.

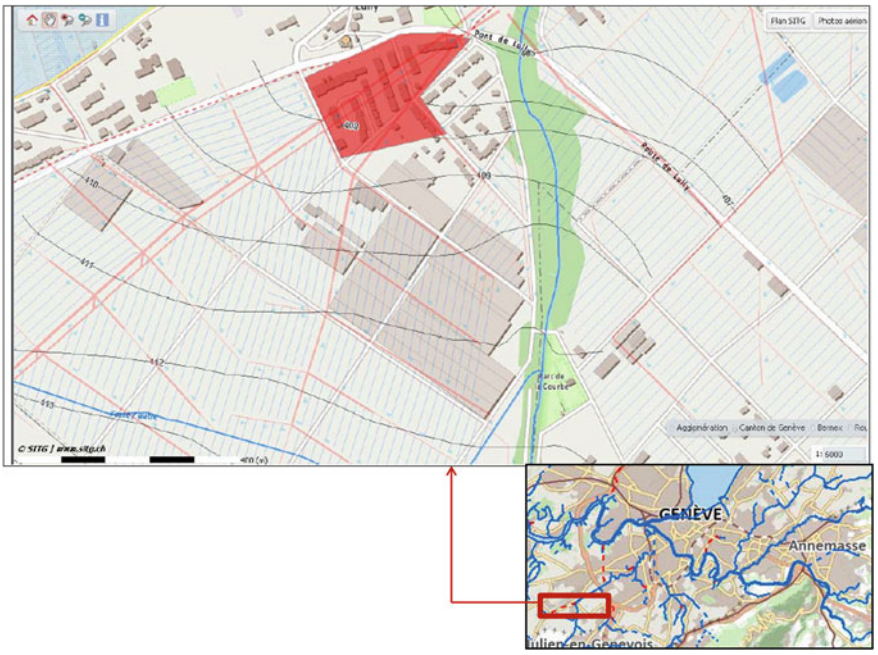

Fig. 9.2 The 2002 disaster in Bernex/Lully: the nexus (agricultural belt) limitations

Therefore, we find back a contradiction between the need to drain the surficial aquifer, in order to support agricultural use of the plain upstream from the built-up areas, and the need to protect built-up areas from flooding. In that case, the local nexus contributed to prepare the 2002 disaster.

9.7 Insights: What Can We Learn from Nexus-Related Policies Concerning the Genevan Urban Area?

The wish to promote policies named after the nexus today is not new in the Swiss part of Geneva. These policies integrated various issues concerning agriculture, water, and energy into the so-called agricultural belt. They tried to find solutions to contradictions and conflicts experienced. The existing official GIS proves the wish to allow stakeholders gaining access to information clearly depicting some of these contradictions and conflicts. Such is the case with the Genevan aquifer management.

Yet, these policies cannot get rid of damages. Some unwanted feedback loops, coming from France, did push Genevan authorities to develop new institutions, cross-bordering, increasing the number of involved stakeholders, at various scales. It is as if the nexus limitations experienced at the local scale would call for the

formation of other nexus type solutions integrating more stakeholders at various scales. This trend is consistent with the internationally driven strategies to promote knowledge management systems (UNISDR 2013; Duncan et al. 2014), but also with research on complexity (Shi et al. 2013). These trends draw attention on the need to address at the same time the capacity to reduce the intensities of future damages (disaster prevention) and the limitations these policies are bound to meet. The more we manage, contributing to reduce the intensities of future damages, the more we contribute to increase uncertainties, and to increase policies limitations. Therefore, nexus looks very much like resilience, as it tries to find the best way possible for living with uncertainties (Pigeon 2014).

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Chapter 10
Renaturalizing Riverbanks and Making Space for the River: Coupling Ecological Concerns and Risk Prevention Measures

Francesco Puma

Abstract Since the approval of the Water Framework Directive (2000/60/EC) in the year 2000, rivers water management within the European Union needed to comply with the increasingly stringent requirements of ecological quality preservation and improvement. In this contribution interventions to rebalance the hydro-morphological dynamic asset of the river were discussed. Such interventions have been identified in the Fluvial Zonation and the Plan for the Hydrogeologic Configuration approved respectively in 1998 and 2001 as well as in the Program for the Management of Sediments carried out in the period 2006–2008. The latter program is based on careful studies and assessments of the unbalance of the sediment production, transport, and deposit mechanisms that have been induced by man-made activities with the aim to restore as much as possible the natural configuration of the riverbed and the riverbanks. The implementation of the plans and the program encounters requires a cultural change among professionals who must be convinced that structural defenses are not the only means to achieve a safer river and that renaturing where possible is preferable both from a hydraulic and an ecological point of view.

10.1 Introduction: The Innovation Brought by the Water Framework Directive

Since the approval of the Water Framework Directive (2000/60/EC) in the year 2000, river water management within the European Union has been required to comply with the increasingly stringent requirements of ecological quality preservation and improvement. The Directive constitutes a common framework for the

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protection of superficial and underground water bodies, including transitional and coastal waters with the objective to:

- Stop further water quality deterioration, protect and improve the state of both riverine and terrestrial, including riparian and humid zones, ecosystems directly depending on the river waters for their own sustenance;
- Promote sustainable water use so as to preserve resources for the future;
- Reinforce protection of the water habitats acting on the control and progressive decrease of incoming wastes, halting emissions and loss of vital substances;
- Guarantee a progressive reduction of underground water pollution;
- Contribute to mitigate the effects of inundations and droughts.

Plans for catchments and surface bodies need to indicate protection measures aimed at achieving the *good ecological state* required by the Directive.

As forecasted by the Directive, the ecological state of water bodies is defined evaluating:

- Biological elements: composition and abundance of aquatic flora, of the invertebrates and fishes for which the age structure has to be considered as well;
- Hydromorphological features sustaining biological elements: hydrologic regime (mass and dynamic of the water flow and connection with the underground water-table), river continuity, morphological conditions (variation in the depth and width of the river, structure and substratum of the river bed, structure of banks);
- Chemical and physical elements sustaining the biological environment: thermal conditions, oxygenation, salinity, acidity, nutrients, specific pollutants.

According to the law, rivers' ecological quality is classified in high, good, sufficient, and low, depending on the degree of man-made alterations, measured through physical, chemical, and hydromorphological indicators. The latter range from values corresponding to no or very limited alteration in the high quality rivers to those showing a high level of alteration in the low quality rivers.

The role of hydro-morphology for the ecological quality is of particular relevance and has to be assessed considering the following aspects:

- Hydrological regime: the surface water bodies mass and the physical and hydrodynamic conditions of the water body are are totally or very similar to the non-altered conditions including the connections with the underground watertable;
- River continuity is not hampered by human interventions; aquatic organisms and sediments are free to move in the water bodies;
- Morphological conditions: the riverbed characteristics, the variation of the water depth and the flow width, the substratum state, the structure and qualitative conditions of the riverbanks correspond to those observable in non-altered rivers.

10.2 The Po Riverbasin Plan Implementing the Water Framework Directive

The Plan for implementing the Water Directive in the Po Riverbasin was approved in 2010 and revised in 2015. In the Plan, an assessment of the morphological condition of the main catchment networks, subdivided according to their morphological parameters (type of riverbed) and stressors, has been carried out. Out of the 308 river corridors pertaining to the 36 main rivers and tributaries of the Po river, only 21 % can be classified as in good morphological conditions, while 42 % are in sufficient condition and 37 % in low or very low quality class.

This situation is certainly due to the intensive use of the floodplain for agricultural production and urbanization. Whilst the latter have certainly contributed to the economic growth of the Country, the exploitation of water resources and the protection from catastrophic floods have led to a dramatic change of the hydraulic and morphological features of the riverbed. River training works aimed at guaranteeing given values for conveyance, at regulating the discharge and the water levels, at controlling the sediment transport, at protecting from floods and riverbanks from erosion, have modified the natural course of the river in a rather drastic way.

Riparian marshes and woods have disappeared to make space for agriculture and human settlements; only few fluvial biotops have surivived. River's ecosystems are not affected only by deforestation, waste disposal sites, pollutants, wetlands reclamation, but also by water withdrawal and by the degradation of the riverbed due to the extraction of sediments that took place particularly between the Fifties and the Eighties of the XX Century. The interruption of the riverbanks continuity has mined also the survival of terrestrial species (birds, small mammals) for which the ecological continuity of their habitat is critical.

In the face of such a critical situation, the Po Riverbasin Authority since its institutional foundation in 1989, has taken a number of initiatives aimed at managing more correctly the sediments in the river and at maintaining the riverbeds on the basis of a careful monitoring of the fluvial dynamics. The aim has been always to reach a better morphological equilibrium and a higher ecological quality, compatibly with the requirements of hydraulic safety and the sustainable use of fluvial resources. Implemented actions were always decided under the assumption that a more natural watercourse is also a safer river.

The issue, however, is not to bring back the river system to how it looked in the past, rather to achieve in the medium-long term and in the widest number of rivers conditions of dynamic equilibrium. This can be done by recovering morphologies that can maintain themselves through natural processes of sediment transfer and deposition, within a riparian zone that is left free from any human conflicting activity.

After the first interventions carried out to manage the most obvious urgencies, the Authority has developed a more comprehensive strategy that is aimed not only at balancing safety, ecological quality and economic requirements, but also at actuating the necessary change in order to:

- Trigger a process of rivers' ecological recovery;
- Control fluvial resources (water, soil, sediments) diminishing the intensity of their exploitation;
- Promote the "river identity" intended as a common good to be shared culturally and socially.

The following key actions are foreseen:

- Preserving or rehabilitating the hydraulic and natural morphological functionality of watercourses;
- Restoring morphological elements in highly altered watercourses with low or very low morphological quality;
- Removing, adapting, managing the existing defenses to improve the hydraulic an morphological processes and the fluvial morphologies;
- Promote the use of water courses that is sustainable with hydraulic and morphological processes;
- Disseminate a culture on the morphological and hydraulic processes of watercourses.

10.3 The Morphological and Environmental Restoration of the Po River

The situation of the Po River is actually the result of a cultural belief that nature and natural resources can be controlled by science and technology and that in such a context hydraulic engineering holds a prominent position.

From the river sources to the delta, the Po River is 652 km long and its catchment totals 70,000 km^2, with an average annual discharge of about 1490 m^3/s for the period 1918–1960 and 1390 m^3/s in the period 1961–1970. The maximal peak discharge at the end cross section of the catchment at Pontelagoscuro, close to the city of Ferrara, has been of 10,3000 m^3/s on the occasion of the catastrophic 1951 flood; the minimal discharge ever recorded has been of 275 m^3/s in 1949. The river runs in the middle of the Padana valley in correspondence to the 45 parallel ending with a delta into the Adriatic Sea; the main levees start upstream of the city of Turin, running for 490 km up to the delta with almost no discontinuity.

Parallel to the main levees a secondary defense system has been put in place: almost 600 km of defenses against bank erosion protect agricultural lands from

minor floods. In the vicinity of the city of Cremona, roughly in the middle of its course, the Po riverbed has been channeled fixing the meanders to permit navigation.

Decennial efforts and huge investments to control river's dynamics have not achieved though the forecasted objectives: the incremental development of levees has been followed by a similar increase in peak discharges and the navigation project has triggered a severe incision of the riverbed. The first incision processes could be observed in the Fifties of the last century, as it had negative effects on riparian defenses compromising their effectiveness, and provoked the lowering of the water table as well as the degradation and loss of natural ecosystems and habitats in the flood plains.

More specifically, the following criticalities can be observed:

- Scour of the bridges foundations and of the levees protection works;
- Making the withdrawal systems out of use because of the reduction of the low stage water level;
- Making the navigation works in the Cremona port unusable due to the 7 m degradation of the riverbed;
- Lowering of the ground watertable triggering the loss of wetlands and superficial water tables with the consequent change and disappearance of marshes;
- Simplification and banalization of the morphological river assets and halting of its dynamic processes with repercussions on the environmental biodiversity and of riparian areas;
- Lack of sediment transport to the sea coastal zones.

Analyses carried out by experts clearly pointed at the dredging as the main cause of the riverbed deepening, as significant correlation between quantities of removed sand and the deepening levels could be calculated. Nevertheless, first limitations by law were decided only in the first years of the Eighties up to a complete stop to excavation, expecting that the phenomenon will consequently diminish. Such expectation proved to be wrong.

The problem has been tackled in the later plans developed by the Po Riverbasin Authority, the Plan for Defining the Fluvial Zonation in 1998 and the Riverbasin Management Plan approved in 2001. Three zones have been identified in the former Plan:

- Zone A, participating to the conveyance of the reference flood;
- Zone B, that corresponds to the whole surface inundated by the reference flood, generally considered as the one with a return period of 200 years;
- Zone C, the surface that is inundated by a catastrophic flood.

In the first zone, the plan foresees "to guarantee safety by allowing the reference flood to flow, maintaining or recovering the riverbed dynamic equilibrium and favoring wherever possible the natural evolution of the river". In Zone B "the goal is to maintain and improve the hydraulic functionality so as to guarantee storage

capacity in case of floods jointly with the preservation of natural and environmental conditions of the river". In this case renaturing interventions are promoted so as to "recover the functionality of natural environments and of typical morphologies, the reactivation of wetlands and the spread of the original vegetation".

Another part of the Plan is devoted to the "programming of sediments maintenance in watercourses, defining methods, technical and operational means to achieve good conditions of hydraulic functionality and of the river environment and morphological conditions". In order to implement this part of the Plan a specific Program for the management of sediments in each reach of the catchment has been approved in the period 2006–2008 following a comprehensive study that assessed the evolution and the quantities involved, the natural causes for the disequilibrium and the anthropogenic factors that have triggered the riverbed incision.

As for the main river, long historic data series are available regarding the plan and altimetry evolution permitting to characterize:

- The current and past fluvial morphology;
- The main morphological features of materials: granulometry, lithology of sediments in bars and banks, characteristics of riparian vegetation;
- Functional processes of the fluvial system with particular regard to production, flux and storage of sediments along the channel.

The main morphologic features of the riverbed, including banks, bars, islands and the low slope channels delimited by works to permit navigation have been observed through surveys and analyzing the many available photos and cartographies. The analysis of erosion and deposit processes in the period between 1982 and 2002 (in which two main floods occurred in 1994 and 2000) were permitted to quantify the variations in plan and volumes taking place in each morphologic feature of the river, to estimate the average annual sediment balance, and to identify reach by reach conditions of disequilibrium and assess their causes.

10.4 Moving Towards Intervention Measures

The program of interventions focuses on the following goals:

- Preserve natural processes where active and still present;
- Reduce the impact of the engineering works made in the past in the riverbed on the natural system, bringing the river towards less bounded forms and a higher dynamic ecological equilibrium;
- Improve the hydraulic safety diminishing the hydrodynamic stress on the levees and guaranteeing the existing uses (withdrawals, ports, docks, navigation channel).

The consequent foreseen actions are:

- Safeguarding all fluvial forms and processes, through continuous monitoring and surveillance;
- Recovery of erosion, sediment transport and deposit processes dismantling or upgrading the obsolescent training works in the riverbed.

Among the proposed interventions, the following are of particular interest:

- Dismantling of 21 km of levees that are not more functional with respect to the current condition of the riverbed;
- Reopening of 29 lateral branches and the reconnection of vagrant, marginal, or deactivated morphologic features to the morphological dynamics of the river;
- Retracement of 3 meanders the natural evolution of which has been modified by the presence of training works creating a risk for the levees.

The implementation of those interventions has faced several obstacles, and up to now only three interventions aimed at maintaining the navigability of the river have been actually carried out. The lack of financial resources is not the only obstacle, equally relevant are difficulties in moving from the decisional level to the actual design and implementation.

In the development of the program the following problems have been faced:

- The prejudice common among professionals that fluvial recovery is not effective and that resources should be directed towards structural defenses;
- The opposition of local communities that see the riparian areas as their own property even though those are often public land, that though have been at their disposal since long ago;
- The juridical constraints that are met when structural defenses have to be removed.

In order to favor a cultural change in the traditional hydraulic approach to promote a new vision consisting of the multifunctional management of rivers it is crucial to push in two directions:

- Reorganize the different fields of river management to achieve a more multi-sectoral and multidisciplinary approach comprising both the river and its environment;
- Reconnect communities, particularly riparian communities to the river;
- Create networks among technical experts, public administrators, institutional organizations and citizens who often can contribute with their contextualized, local knowledge that is strategic for regional and environmental management.

To summarize we need to promote a shared culture of the river and its environment, eliciting the main values and resources that it entails and of rules of sustainable management that should guide any type of riparian or territorial transformation (Fig. 10.1).

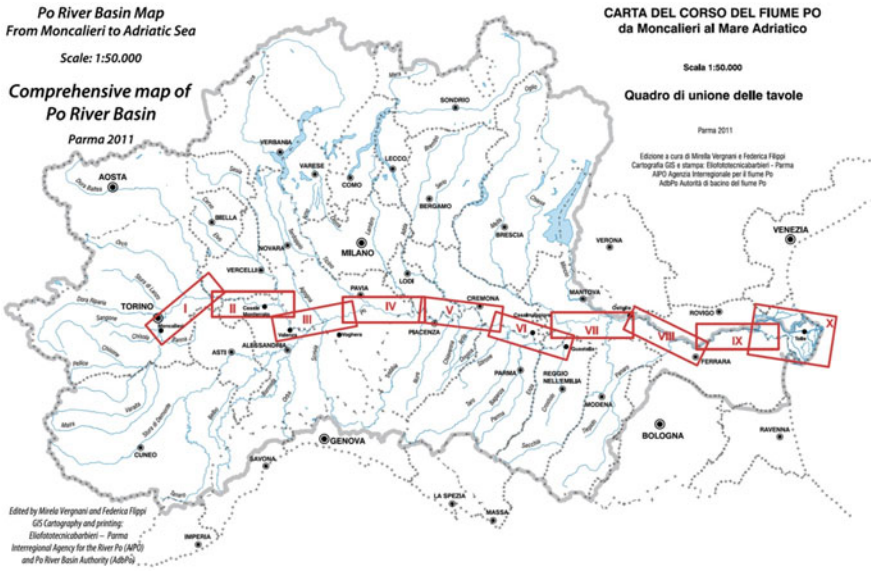

Fig. 10.1 "Po River Basin Map. From Moncalieri to Adriatic Sea. Comprehensive map of Po River Basin", original scale Scale: 1:50.000, Edited by Mirela Vergnani and Federica Flippi, GIS Cartography and printing: Eliofototecnicabarbieri – Parma, Interregional Agency for the River Po (AIPO) and Po River Basin Authority(AdbPo), Parma 2011

Chapter 11
Exploring the Water-Food-Energy and Climate Nexus: Insights from the Moroccan Draa Valley

Guido Minucci and Ahmed Karmaoui

Abstract Water, energy, food and climate are strongly interconnected spheres ranging from ensuring access to resources and services, to environmental and social impacts. Such interwoven concerns become even more relevant in drylands and oasis communities in developing countries where resources are already scarce and people are considered to be among the most endangered by the rising anthropogenic pressure on the environment and threats posed by climate change. Pinpointing these links is extremely relevant since it allows addressing synergies and preventing potential tensions. Using the Draa Valley Region in Morocco as a case study, the paper addresses and maps the interconnectedness between water-food-energy and climate. The findings of this study underline that while (national and regional) top-down policies concerning water-food-energy and climate nexus goal to take control of the related interconnections put at risk the long-term sustainability of the region in the area of water, energy and food; bottom-up and local policies are able to accommodate and respond to change posed by the nexus challenges in the short-term.

11.1 Introduction

Recently the water-energy-food nexus has been promoted as an emerging global development paradigm and research agenda (Middleton et al. 2015). There are different conceptualizations and combinations of nexus and as consequence, numerous frameworks are developed to identify the types of interlinkages and tradeoffs between diverse systems, in particular between water, energy, and food

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sectors as they are at the core of human needs. The dominant approach to understand such trade-offs and synergies is through socioecological systems thinking (Hoff 2011). Within this context, understanding the multidimensionality and complexity of the issue is particularly relevant for drylands as highlighted by the International Conference on the "Water-Energy-Food Nexus in Drylands" held in Rabat during June 2014. Drylands host one-third of the global population, cover 41 % of the land surface and are faced with greater challenges with respect to water, energy and food than other regions. Physical water scarcity is either already a major problem or may be exacerbated by climate change and over-depletion of available water resources.

This paper seeks to increase understanding of the interlinkages in the water, energy, and food nexus in the dryland of the Draa valley in Morocco. It argues that focusing on trade-offs and synergies using a nexus approach could facilitate adaptation to current and future stresses and shocks by enhancing (food-water-energy) resource use in a more resilient manner and by encouraging greater policy coherence.

11.1.1 Introduction to the Study Area

The Draa Valley (UNESCO biosphere reserve) is located in the South part of Morocco between the Altas Mountains and the Sahara desert. Hydrologically, the Draa Valley territory is divided into two sub-catchments or valleys, the Upper Drâa and the Middle Drâa (Fig. 11.1). The former is part of the Ouarzazate province; the latter is part of the province of Zagora and consists of a chain of six oasis. The valley is characterized by scarce and irregular rainfall and by high evaporation rates due to the frequency of storms and high temperatures, which prevail in most months of the year. This region is highly vulnerable to drought events, which here are frequent and severe and have devastating impacts on population and economy.

11.1.2 Expected Effects of the Climate Change in the Draa Valley

A study carried out by Adaptation to Climatic Change in Morocco for Resilient Oasis (PACC/OASIS) project shows reduction in total average rainfall for the entire valley in the winter season and an increase in the annual average temperature. Such variation will induce both the reduction in vegetation cover and water resources availability, and an increase in soil erosion and reservoir siltation and the lessening of water resources. This will affect one of the key sector in the economy of the valley, the agricultural production as water is supplied for irrigation from the dammed Draa.

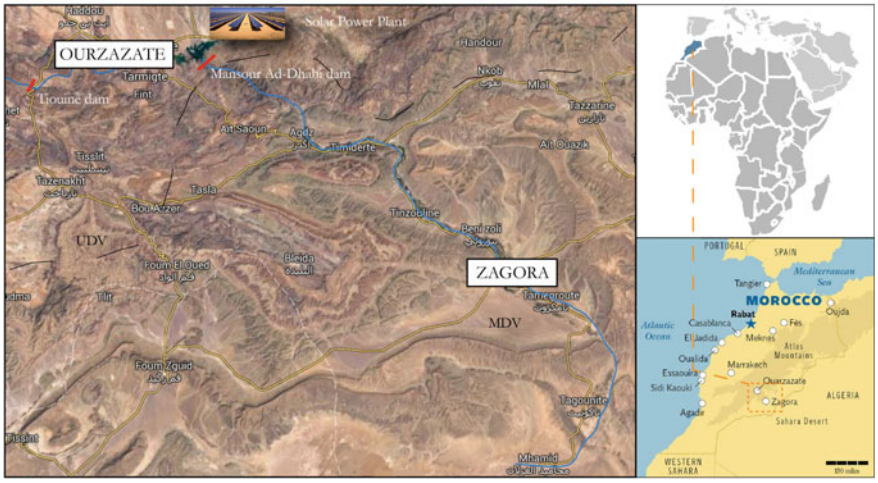

Fig. 11.1 The Draa valley divided into two catchments (the Upper Drâa (UDV) and the Middle Drâa (MDV) valleys) (Google Maps *Authors*)

In this context, the National Plan for the Fight against Climate Change launched in 2009 aims at reinforcing government action in facing climate change. However, currently, there is not a formal body working on climate change mitigation in place at either national or regional level.

11.2 Exploring Relationships Between Water-Energy-Food in the Moroccan Draa Valley

In the following sections, we investigate top-down policies and local actions concerning water-food-energy nexus, which have cross scale influences and dynamics.

11.2.1 The Moroccan Water Management Strategy

After the independence of Morocco, the government planned several national energy production projects for the country development. In this context, the objective of building the Mansour Ad-Dhabi dam was threefold: (i) provide regular irrigation along the valley, (ii) protect from flood events the agricultural land, and lastly, (iii) to produce electricity. However, unforeseen declines in rainfall and high evaporation rates threatened the ability of this dam to function sustainably during the ‘80s and early ‘90s. The dam construction had strong consequences on the entire valley system. The most relevant being: the drying up of the downstream

groundwater table; loss of soil fertility due to the sediments retention behind the dam; the increasing soil and ground water salinity, and; changes in the social system and human adaptive strategies (Chelleri et al. 2014). Thus, what originally the dam construction wished to avoid (environmental crisis thanks to the regularization of the river flows) became paradoxically what the dam itself enforced.

11.2.2 Interconnections Between Food Dependency on Water and Water Dependency on Energy

In response to the dam construction effects and the frequent drought events, both farmers and governmental institutions have applied different strategies to ensure irrigation to crop fields and face changes occurred in the Draa Valley Region.

Farmers favored by an increasing access to and affordability of rural electricity, diesel pumps autonomously adapt to both the functional disruption of the dam and the water shortage by shifting from surface to groundwater irrigation by (legally and illegally) digging private wells. An example of how such practice has been taken to the extreme is the case of the Feija Imssoufa, where Zainabi (2003) reports that at for an area of 350 ha were digged 226 wells and equipped with 171 pumps, an average of one well every 2 ha. Such transformation in the irrigation strategies has resulted in a strengthening of the energy for water dependency as shown by the steady growth in the number of water pumps from 2000 in 1977 to around 10,000 in 2011 (Chelleri et al. 2014) with stronger impacts of soil and ground water salinization in the downstream oases.

The digging wells practice has generated several effects, such as valuing areas by expanding the irrigable area of the oasis as shown by the emerging watermelon cultivation; the uncontrolled use of wells has contributed to the decline of the water table of the oasis and to a rise in the level of salt concentrations.

In 2008, the government released the Green Morocco Plan (GMP), the new national agricultural plan. It aims at maximizing the output from the intensive agriculture in order to reduce the dependence of the country on cereal imports and to limit the migration from rural areas by supporting local farmers. Because almost 90 % of the total budget (Maroc 2008) is allocated to achieve the first pillar, it is likely that smaller farmers will not really take advantage from this GMP since they do not cultivate to export their products. Therefore, the real risk tied to this policy is that stimulating such intensive production will have as effect exactly the opposite to the desired ones. As it is already happening with the case of watermelon cultivation, which is both accelerating the water crisis and ensuring a better economic security for farmers in the short-terms. Consequently, the GMP may negatively affect the regional (and maybe national) capacity to produce food for its population due to cross-scale effects and trade-offs caused by unsustainable intensive production.

11.2.3 The (Cyclic) Strategy of Building Dams

The new national strategy entailed heavy investments towards the construction of dams for increasing water supply capacity and secure water for urban and agricultural demands even though the majority of easy gains have already been made. This new strategy is applied in the Draa Valley with the construction of the Tiouine dam, upstream from Ouarzazate. Despite the effects of the Mansour Al-Dhabi dam, the government aims at responding to the current water demand by applying again a structural approach finalized to satisfy the rising demand. Whereas, there is a need of changing the water management approach and looking at new solutions, which could be given by looking at the existing interactions and interdependencies among the different nexus factors. Instead, the application of the command-and-control approach shows how the current water-food system lack for rules that capture the costs of natural ecosystem. There is a strong need of rules that clarifies and notifies to water system managers and governmental officers the consequences of neglecting natural resource scarcity. It is worth noting that conflicts seem to already occur between users regarding water for food production and water to satisfy urban and tourism water demand. Conflicts concerning water uses rose in particular after American cinema industry, which had invested in Ouarzazate city by building one of the largest movie studios in Africa. Looking at the Drinkable Water Office database, Ouarzazate hotels alone reached 40 % of the total urban water consumption (ONEP 2010), while the Zagora's water use rise from 15,967 m^3 (4 % of the total water uses) in 1982 to 89,575 m^3 (13 %) in 2000, which means an increase of 461 % (Ministère de Tourisme 2011). As underlined by Casciarri (2003), the water consumption for tourist purposes augmented significantly amplifying further water scarcity and groundwater (and soil) salinization in the southern oases because of upstream water extraction. Yet, the government launched a project upstream of the under construction Tiouine dam in order to support the agricultural activity. The new dam construction and the GMP all realized under the umbrella of improving the food (and human) security are pushing the agriculture production towards a cereals and export oriented agriculture, which may be harmful for the long-term resilience and sustainability of the valley due to its extremely high water consumption rates. Current transformations in the valley and conflicts hailed from them are prompting a transition from a traditional (environmental and ecosystem functioning knowledge) society, with common and participative resource management practices, to a society where the equilibrium among the factors composing the water-food-energy nexus is unbalanced in favor of one component accordingly to circumstantial convenience. Thus, making water-food-energy nexus dependent on external markets and subsides, not participative, nor resilient but top-down and environmentally unsustainable.

11.2.4 The Moroccan Renewable Energy Ambition

In recent years, Morocco has imported 95 % of its energy as fossil fuels, providing subsidies on these fuels at a cost between US$1–4 billion per year (IEA 2014), which has created huge financial pressures on the state to reduce energy subsidies (Vagliasindi 2013). Since 2009, a change in the Moroccan energy sector has occurred developing a new national energy redirecting energy supply from importing to renewables energy production. Renewables should represent 42 % of installed capacity by 2020.

11.2.5 Energy-Dependency on Water: The Cloudy Moroccan Dream About Solar Power

In this context, the Morocco Solar Plan object is to provide almost one-fifth of Morocco's annual electricity generation through solar power by building mega-scale solar power projects at five location, one is in Ouarzazate. The plant is expected to be complete in 2019. The solar complex with a total capacity of 500 MW and an estimated output of 1.2 TWh/year to meet local demand will be the world's largest solar thermal power plant. It will contribute to accomplish the national climate change scope by avoiding CO_2 emission for 3.7 millions of tons (ADB 2014a) and to reduce foreign energy dependency and import costs. However, to be operative the solar power plant in Ouarzazate will have a relevant cost in terms of water withdrawal, around 3 Mm^3/year, from Mansour Eddabhi dam to run the "humid" cooling system characterizing the first phase of the solar power plant (ADB 2014a). Whereas, a dry cooling system will be used to run both the second and third phase of the solar power plant. Compared with the wet system, the dry cooling system will require a much less water amount 355,000 m^3/year (ADB 2014b). Nonetheless, energy supply using fossil fuel is crucial to run this dry cooling system to satisfy the functional requirements (e.g. maintain the eutectic salts at high temperature so that they remain liquid). Hence, a back-up fuel of 19T/day of gasoil for a capacity of 500 MW is needed (ADB 2014b). Therefore, the advantages given by the implementation of a dry cooling system, which will allow saving water in an area prone to drought, seems to be reduce by the fact that a part of the plant needs water to be operative and in case of a severe drought event may be a (co-)cause of conflicts between different sectors. On the other hand, having a back-up based on gasoil reduces the benefit of such alternative due to the impact of the gasoil supply system and the connected risk of soil pollution. Thus, such a system could not be the most resilient, nor sustainable option. Besides, the project for the solar power plant states that part of the energy produced will be used to satisfy the local energy demand, however the same project does not clarify which will be the rate of coverage for this kind of energy supply service.

Table 11.1 Overview of the biomass potential in the Draa Valley. *Source* Realized by IfaS (GTZ 2010)

Sector	Quantity	Technical Potential (MWh/y)	The tone of oil equivalent (t/y)	CO2 equivalent (t/y)
Agriculture		252.142	21.690	82.475
Vegetal production	49.227 t/y	138.878	11.947	38.755
Animal production	79.100 LCU	113.263	9.7443	43.720
Forestry	8.341 m3/y	18.352	1.579	5.047
Wastewater treatment	386.586 EH	16.701	1.440	6.446
Waste	125.391 t/y	35.243	3.038	13.613
Total		322.437	27.746	107.580

LCU: Large cattle unit, PE: population equivalent

In the rural areas, wood fire is the main energy source and it is used daily to meet the needs of households and for commercial purposes and as shown by a study carried out by Karmaoui (2015) the firewood consumption has not significantly decreased in the last twenty years.

A study conducted by the Institute of Materials Flow Management (IfaS) has assessed the potential of biomass distinguished per sectors (Table 1.1) to produce energy in this manner in the whole Souss-Massa-Draa region. In the Draa Valley, the biomass potential resulted to be relatively low due to climatic conditions. However, the study leaves open the possibility to start-up a biomass energy production in this area without taking into account the possible future conflicts among sectors (e.g. food vs. energy production) and between users that may arise from such energy production business.

11.3 Water-Energy-Food Relations, Current Policies and Future Challenges in the Draa Valley Region

The interconnections between water, energy and food have been mapped (Fig. 11.2) in order to visualize the type of relation (i.e. dependency-on or impacts-from) existing between water, energy and food factors within the ongoing transformations in the Draa valley region. In detail, the green links refer to dependency-on relation, e.g. the need of water for producing solar-energy, whereas orange-links identify impacts-from relations, such as loss of water quality and pollution from farming and hydropower generation. As results from Fig. 11.2, the ongoing transformations are prompting a transition from a traditional society to a society where the equilibrium among the factors composing the water-food-energy nexus is unbalanced in favor of one component accordingly to circumstantial convenience. Despite some efforts to think to the interlinkages among the different factors composing the water-food-energy nexus can be identified in those policies

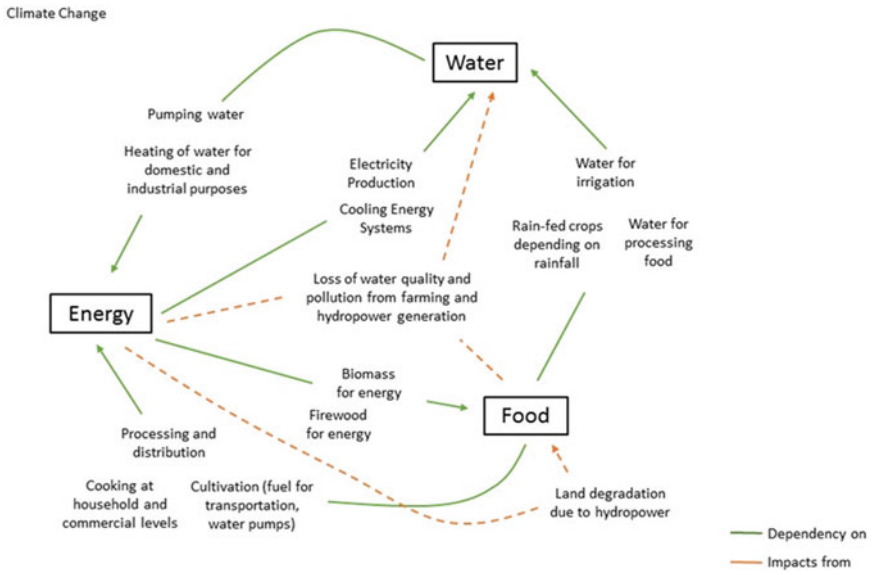

Fig. 11.2 Water-food-energy dependency-on and impacts-from relations

looking at mitigate future impact of climate change, the analysis of the top-down policies has highlighted how the existing twine among the different nexus factors is not integrated and enhanced within current policies. Indeed, the analysis emphasizes how those policies are not designed and applied to move beyond silos thinking in order to increase the opportunities for mutually beneficial responses and enhancing the potential for cooperation between and among all sectors. Therefore, a nowadays challenge for enhancing the future of the Draa valley is to fulfil the current gap concerning the lack of a general framework to develop appropriate policies and investments, to exploit synergies and mitigate trade-offs among the development goals related to water, energy and food. Moreover, according to the nexus perspective, an active participation and collaboration by and among government agencies, the private sector and civil society will be needed in order to achieve the goal of defining a general framework so as to meet increasing water, food, energy demands without compromising sustainability.

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Chapter 12
Peri-Urban/Peri-Rural Areas: Identities, Values and Strategies

Angela Colucci

Abstract The first part of this essay introduces discourses on definitions of Peri-Urban/Peri-Rural areas underlining main existing and consolidated approaches and needs towards a renovated conceptual reframing able to emphasise the "transitional" values of these areas. A renovated approach needs a realignment of existing methods and solution in the different spheres characterising the transformation process. Based on the "ecotone" metaphor to emphasise specific characteristics of urban-rural transitional buffer, the second part underlines main opportunities offered by Peri-Urban areas in a Nexus and integrated approach. Opportunities of innovation related to the whole process of interpretation, design and implementation/management of polices and projects aiming an improvement of resilience of Peri-Urban/Peri-Rural areas and regional territorial systems (Colucci 2012).

12.1 Introduction

The essay focuses on a specific but complex and crosscutting issue: food (polices) in Peri-Urban areas whit a nexus approach. The "focus" refers to three complex concepts characterized by consolidated disciplinary approaches, theoretical principles and/or models. In relation to these literature backgrounds the essay highlights only few aspects: (a) concepts/aspects of "intersection" among these conceptual frameworks (and related models) and (b) needs of re-alignment (more than a innovation/renovation) of knowledge, design and governance methods and instruments towards integrated solutions. From the actual debate among researchers and experts [on Peri-Urban/food polices/nexus] the need of interdisciplinary and crosscutting solutions is emerging. This process of re-alignment has to involve

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different spheres: the knowledge, interpretative and assessment models, the governance and decision-making process and the design, implementation and management instruments and solutions. This advancement needs to approach the complexity emerging from considering the interrelations between the Peri-Urban areas and the food polices and their mutual interdependencies with water and energy (and other metabolic cycles and flows) in a Nexus approach.

12.2 Peri-Urban/Peri-Rural Dichotomies

The first discourse is the "definition" of "Peri-Urban" areas concept. A large literature on urban development (planning and urban design disciplinary debate) has explored (and explores) the "topic" of Peri-Urban areas in relation to the phenomena of urbanization (sprawl, new urbanization trends and characters, megalopolis, new informal/illegal urbanization etc.)[1] In general, urban design and urban planning approaches apply to new phenomena related to Peri-Urban areas consolidated interpretative and design models deriving from the "urban sphere". The word "Peri-Urban" itself refers to a condition of "near" or "a border" of a urban pattern/core. A large range of researches on Peri-Urban areas focus on the metaphors of fringe of urban peripheries developing proposals based on the consolidated "urban solutions-toolbox".[2]

Urban design proposal emerging from disciplinary debate introduce renovated visions and solutions focusing on intermediate spaces that are interpreted as opportunity for the metropolitan development. These proposals integrate the economic and social aspects (economic and social crisis of urban systems) with green and environmental issues and promote solutions for metropolitan systems integrating urban/rural patterns.

Recent researches and polices propose alternative and more innovative conceptual reframing. As Pedrazzini underlined European Polices on Spatial/Regional Planning suggest a renovation in Peri-Urban discourses considering the role and potential of these territories from regional to local scales. Peri-Urban territories have to be recognized in their specificities and as transitional buffer of connection and stabilization of relationships between urban and rural/natural areas.

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[1]For example, in the Italian context planning disciplinary debate has focused on the sprawl phenomena and on the interpretative categories of new urbanizations patterns and trends (the "megalopoli padana" of Turri) and (b) reduction of soil consumption and preservation of agricultural productive surfaces developing planning instruments (spatial planning and land uses solutions, laws) that act on the "rural" landscapes.

[2]In last decades in architecture disciplinary debate it is possible to find different approaches and proposals to approach the design of "rural landscape" some examples develop ideas for a "rur-urbanization" or new urbanization models of rural contexts with different level of artificialisation and integration between urban and rural patterns and other researches focus on design needs and solution for rural architecture (Agritecture).

Different polices, models and consolidated proposals derived from the literature and researches on ecosystem services (TEEB 2011, 2014 and MEA or TEEB web platforms) approach the "urban-rural" relationships in terms of metabolic flows (urban metabolism). Ecosystem services (see the Bisogni, Colucci, Gibelli essay) can give relevant contributions in the development of integrated model of design and planning between urban and rural/natural patterns.

Food polices are a typical crosscutting polices that involve different scientific fields and disciplines and that act on all the components of territorial systems (environmental, social, economical…). In recent years the food and food polices became central in scientific and political issues. This year, during the Milano EXPO2015 a "food polices pact" was signed among several majors of metropolitan areas of all the world (Milan Urban Food Policy Pact and Milan Center for Food Law and Policy).

12.3 Urban/Rural Transitional Buffer

In order to connect innovative proposals towards an interdisciplinary set of interpretative and design/planning framework, it is useful to assume a new paradigm to define and interpret the Peri-Urban/Peri-Rural areas. The Peri-Urban/Peri-Rural areas could be assumed as "Peri-Urban landscapes are the fringe regions of cities that are defined spatially and functionally by their intimate relationship with nearby urban metropolitan areas and the rural hinterland" (Buxton et al. 2006; Ivesa and Kendal 2013, Acha et al. 2015). Peri-Urban/Peri-Rural transitional buffer could be interpreted as ecotonal transitional buffer.[3] The ecotone metaphor can support the connection among various phenomena that characterize these areas:

- integration between local and regional spatial scales: the ecotone are local based (each ecotone has specific characteristic) but the ecotone components and characteristics are influenced and derive from the biomes. In this terms the rural/urban transitional buffer has specific and unique characteristics but these are related with urban and rural/natural systems.
- coexistence of different time-dynamics: in ecotones coexist rapid transformation and slow transformations related to the evolution of biomes and the habitat. The Peri-Urban transitional buffers are typically areas where coexist fast and temporary transformations (renovations trends, informal land uses, temporary function/uses…) and long terms trends (historical urban and rural landscape patterns and values…).
- emergent proprieties characterise ecotonal buffers: identification of all resources and the specific values of Peri-Urban systems (that cannot be assimilated to

[3]The concept of "ecotonal transitional buffer" as metaphor useful to support a renovation of existing methods and design/planning process was proposed in relation to the consulting activities for URMA INTERREG IVC project (Colucci 2015).

urban or rural or natural systems) in terms of opportunities emerging from the relationships of urban and rural/natural patterns and components.

- richness (in biodiversity) and conflictual dynamics characterise the ecotone: also these two characteristics could be useful for the interpretation of a large range of phenomena characterising the Peri-Urban buffer (a mixed mosaic of function usually characterise Peri-Urban areas where it is possible to recognise commercial, residential, industrial, heritage or historical centers, agricultural production and farming, natural landscapes…). The coexistence of this mixed mosaic of functions and characteristics if it is a richness and opportunity implies also the existence of local conflicts (social, environmental and between different interests…).

The Nexus approach emphasising on the connection and integrated polices between food, water and energy could be a useful interpretative framework to approach the Peri-Urban areas as transitional buffers.

12.4 Opportunities and Perspectives

In these terms Peri-Urban areas could be interpreted as "transition zones" that can perform services and offer opportunities both to agricultural and urban systems (Colucci 2015; Colucci and Magoni 2015). To identify these opportunities an integrated multi-scale perspective is necessary: the regional perspective is necessary modelling the complex territorial systems and it has to dialogue with the local and micro scales. In this dialogue the Peri-Urban areas can be recognized with specific values and opportunities given by their ecotonal condition. Articles/papers moving from food polices and urban-rural partnerships underline and focus on main relevant aspects to reach a renovated approach to Peri-Urban areas in a Nexus approach.

- Multiscale. The food chains include local and global scale and the food planning could not be closed in a local dimension. The strategic vision based on an integrated and crosscutting approach needs multidimensional scales in order to improve local/regional dimensions and manage, at the same time, the "global" relationships. In the URMA Interreg IVc project (see Kniling et al. essay and the reports of the Project "Urban-Rural Partnerships in Metropolitan Areas": URMA 2014a, b, c) the coexistence of different scale of partnerships from local or inner-urban to regional or trans regional scales emerged and this multiscale perspectives has to characterise also the governance process. The multi-scale perspective has to include also the temporal dimension: in Peri-Urban areas different time-perspectives coexist and have to be considered, integrated and managed.[4]

[4]The food and agriculture production that is connected to seasonal period/time related to food production, urban flow and communities lifestyle, the metabolic flows and long period of water

- Crosscutting and interdisciplinary. Nexus approach could support crosscutting polices: shifting the focus of observation from "map" to "flows". Urban and rural components of complex territorial system are interlinked and connected by several flows: environmental metabolic flows, social and cultural flows, economical flows etc. In particular, the mentioned flows play a crucial role in the food planning at regional and local scale and the Peri-Urban areas offer a buffering systems where these flows could find "physical" inter-link points.
- Diversity and redundancy in function and services. Peri-Urban areas could be structured in relation to three main "services/functions" categories: (1) Environmental and ecosystem services (metabolic services) related to metabolic cycles (e.g. water, carbon sequestration and climate regulation, economy of ecosystems and biodiversity, the role of green infrastructures) (see Bisogni et al. essay); (2) Services to economic development/economic innovation (see Bisogni et al.; Pesaro essays); (3) services and functions for communities and to social inclusion in a integrate urban/metropolitan regeneration: Peri-Urban areas are traditionally "fragile" and "fringe" territory (characterized by social conflicts, local conflicts on land uses…). In this terms a process of recognition of critical phenomena could reverse this feature as an opportunity towards innovative use of Peri-Urban areas.
- Visioning and multistakeholders process. Approaching the food planning in a Nexus perspectives implies a shared definition of future perspectives: strategic vision is a mean for the involvement of a large range of actors that are fundamental (and needed) during the implementation and management of urban rural partnerships. The strategic visions imply both European/regional priorities/polices and the definition of local vision (Longworth 2006). The process for the strategic vision definition that should accompany the whole process/cycle of initiatives (from the beginning to the management) need to maintain a certain openness in order to intercept and implement unexpected and innovative solutions. On this aspect the involvement of different knowledge plays a relevant role (demonstrated for instance by the implementation of the "quadruple helix" in Twente, and by other cases presented): local and traditional agricultural knowledge (memory), research and academic (and students), private and entrepreneurs, experts and institutional staff, associations and NGOs…
- Opening the process to a large range of actors supports also a fundamental step in the strengthening of resilience of Peri-Urban areas: identification of resources and envisioning values. To recognise environmental, social, economic resources in a multi-dimensional perspective allows the activation of initiatives and projects able to "focus" on food planning including integrated solutions for water management, local energy supply both for rural and urban systems.

(Footnote 4 continued)

cycle, different time-perspectives of Peri-Urban and urban transformations, long-terms period of environmental and social trends and dynamics (climate change, social structure and social/economic trends)…

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Chapter 13
Local Food Chain: Multi-stakeholders Policies in Dutch and European Policies

Rolf Oldejans

Abstract Introducing a critical phenomenon due to the "Dutch food industry" in the last century, this paper underlines the urgencies and causes from which moved an innovation and revision of food policies in the Dutch context towards a more sustainable model of food production and distribution. The Dutch region of Twente accepted this challenge and launched the Green Knowledge Portal Twente that is a "platform" of cooperation between local and regional authorities, knowledge institutes, citizens and farmers to develop and implement innovative polices for food production, transformation and distribution based on the criteria of reduction of "foodmiles" and "foodprint". The Green Knowledge Portal puts the quadruple helix approach into a practice involving, in the same process, governments/institutions, students, organizations/citizens and entrepreneurs to develop and implement new, fresh ideas and solutions.

13.1 Looking Back

History shows the importance of good cooperation between urban and rural society about the production and distribution of food, water, materials and energy. This kind of cooperation was an organic one. However, the growth of civilisation lead to a distribution on a larger scale. The bigger the world became for the urban society the more products were distributed on longer distances. Especially for food, new preservation techniques made it possible to send fresh food all over the world. At first food from far away was mostly meant for the people who could afford it, royal houses, aristocrats and merchants. In the 20th century these kind of luxury goods became also available for the common people and thanks to more efficient distribution means, daily food could be produced everywhere and could be distributed to all corners of the world.

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The reverse side of this development was that the worldwide distribution caused a huge rise of carbon dioxide emission, an effect that was not discounted in the food prizes, because these costs were on account of the local and/or regional governments that had to deal with these negative effects. This was the only way to keep the prizes of food affordable. In fact this meant a passing of the responsibility for negative effects from the consumer to the taxpayer.

Another negative effect was an expansion of the food chain with many links of intermediaries who benefitted by the addition of value to the food chain. Food distribution became more and more a vehicle of specialisation. Especially in the Netherlands, food production was fully supported by the national government by providing knowledge of universities and other knowledge institutes to farmers and farmers organisations. Efficiency of food production became the leading principle in the Dutch food industry, with more and more emphasis on "industry". This policy was internalized in the EU policy and by EU subsidies this efficiency was stimulated even more. So the Dutch policy became the EU standard.

A side effect was that people lost contact with food because the production of food was hidden in factory buildings more and more, like a black box.

The economic crisis that started in 2007 changed the minds of many people and lead to an awareness on the limits of growth. This awareness caused a growing public attention to urban gardening and regional products. Ideas on the reduction of foodmiles (the distance that food is transported as it travels from producer to consumer, including the CO_2 emission used for the distribution of food) and on the "foodprint" (space needed for the production of, including the space needed for the production of food for animals) became more popular.

A number of food scandals increased this awareness and provoked more control on the very complicated food chain and a growing demand for areas to grow your own food, like allotment gardens. Interesting was the growing pressure for the re-use of vacant building land for the purpose of urban farming, especially by giving opportunities for citizens to discover the skills of farming. Most of this land was rented or given to citizens temporarily, for 5–10 years.

Another effect of the crisis and the food scandals was the advance of regional production in the Peri-Urban areas. It started with the growing need of better quality and "authenticity", but due to the fear for new food scandals citizens chose more and more for simply controlled food production within short and more transparent food chains. The shorter the distance between producers and consumers, the more a natural common mutual bond between producers and consumers can be felt. This also promotes the special identity of the area. A combination with other functions like tourism strengthens this identity even more.

Production of food nearby the consumer's market and the distribution within a limited range leads to more sustainability: it reduces the food miles and it also leads to reduction of carbon dioxide.

The attention to local and regional products must also be seen from the perspective of public health. More attention to the production of food nearby creates more awareness. For young people it is an opportunity to take notice of the way food is produced, an aspect that has been neglected in education for many years.

The change of attitude towards food nowadays raises questions about the role of government. Obviously public health and the supply of food is a public interest and justifies a public intervention. However, the economic crisis diminished the financial capacity of government to stimulate this development of local food chains. Without the financial governmental support new more creative approaches had to be found for a change.

13.2 The Green Knowledge Portal Twente

In the Dutch region Twente it was the Green Knowledge Portal Twente that accepted this challenge. The Green Knowledge Portal Twente is a cooperation of local and regional authorities and knowledge institutes to make use of students to deal with regional issues. These students from several levels (from vocational studies until university) learn to apply their skills in practice. Companies, citizens, NGO's as well as governments will obtain new fresh knowledge which will lead to more innovation in an easy way. The use of students is also a smart way to make the region more attractive because of interesting issues, which may persuade these students to stay in the region and even start their own enterprises. In that way it could be helpful to stop the brain drain.

For new food approaches, the use of knowledge is very welcome. It provides new innovative approaches to old traditional food chains and products. The Green Knowledge Portal Twente makes use of students to trigger entrepreneurs to take the responsibility for building up a local and/or regional food chain. Entrepreneurs have always a focus on profit, but if they are helped by knowledge they are also willing to take a step further.

In several food projects students advised small companies to cooperate more, even in cooperatives. In the region Twente one cooperative has been founded, a cooperative on distribution, with entrepreneurs and owners of restaurants and food shops as members. There are also other combinations possible, e.g. a cooperative of consumers and producers (food subscriptions).

13.3 Looking Forward

Building up a food chain takes time, and most of the times it will grow slowly. It concerns large groups of small enterprises and the only way to survive in the future will be to cooperate. In this way, costs can be reduced and together they are more powerful in marketing. The common use of a website to order products is also a very good trigger to cooperate, next to the specific use of quality standards. With more cooperation, risks could be spread which leads to more continuity.

The production and distribution of food leads to employment opportunities for less educated people and for people with physical and mental handicaps. The use of these people can also add value to products, an interesting aspect that promotes more involvement of society and more connections between people living in cities and the countryside.

Students can help to think out these constructions and new market opportunities. By making use of students it will be easier to experiment on new product combinations and innovations.

This all shows that the recovery of food chains leads to more cooperation and greater involvement of stakeholders. The recovery can be initiated by a sensitive process of "push and pull" by local and regional governments where entrepreneurs will be seduced to take the lead via the offering of knowledge of students and the hands of people with limited capacities. Then local and regional food chains become more a product of cooperation and it makes them more sustainable. History repeats itself but in a more modern way. We call that "innovation" (Fig. 13.1).

Fig. 13.1 Images from the web site of Green Knowledge Portal Twente (Green Knowledge Portal Twente, Website: http://www.groenekennispoort.nl)

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Chapter 14
Urban-Rural Partnerships in Peri-Urban Areas: The Role of Non-profit Organizations

Elena Jachia

Abstract In the last few years Fondazione Cariplo (Cariplo Foundation) has been promoting many initiatives related to the enhancement of new partnerships between cities and their countryside. Their focuses were the development of sustainable and multifunctional agriculture in the Peri-Urban areas and the transition from conventional monoculture agriculture to organic agriculture integrated in local food chains. Fondazione Cariplo's aim is to contribute to achieve to different challenges, such as the reduction of soil consumption, guaranteeing good food to cities from neighboring areas and reducing transport emissions and costs. Several projects on urban-rural partnerships were supported since 2009, mainly located in a specific critical area called Parco Agricolo Sud Milano (PASM), the second largest agricultural park in Europe, and some of them will be described in this chapter. Environmental NGOs, often supported by Universities, usually promote grassroots initiatives. A first group of them focuses on promoting consumer awareness and more sustainable food production, a second one is aimed at promoting countryside landscape and environment and maintaining an acceptable equilibrium between settlements and open spaces. Fondazione Cariplo also supports research on food policies at regional and municipal level with the aim to contribute to the development of a public polices framework on food policies. In particular, Fondazione Cariplo was the main partner in the development of the Food Policy for the municipality of Milan.

14.1 Introduction

Over the last few years Fondazione Cariplo has been promoting many initiatives related to the enhancement of new partnerships between cities and their countryside, focusing in particular on food systems' environmental sustainability,

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agricultural biodiversity, the increasing demand for organic food, the diffusion of new distribution systems, namely community supported agriculture and solidarity based purchasing groups (GAS).

Particular attention has been paid to the development of sustainable and multi-functional agriculture in the Peri-Urban areas and to the transformation from conventional monoculture agriculture to organic agriculture integrated in local food chains. In this way the Foundation intends to contribute to answering different challenges:

- reduce the soil consumption dynamics,
- provide food of good quality to cities from neighboring agricultural areas, and
- reduce emissions and costs from distribution and transports.

Fondazione Cariplo supported several projects on urban-rural partnerships, mainly located in Parco Agricolo Sud Milano (PASM) that is the second larger agricultural Park in Europe and one of the largest European belt parks. The PASM is surrounding the southern part of Milan metropolitan area with a surface of 47,000 ha, 38,000 of which are cultivated. In the PASM approximately 1000 farms are actually active, but an increasing urbanization dynamic is threatening their existence.

In order to maximize synergy among the different funded projects, a Working Group among them was set up and coordinated by Fondazione Cariplo.

Activities were funded in three main areas:

1. grassroots initiatives able to raise the number of increasingly aware consumers and more sustainable food producers and the development of direct relationships between the two groups;
2. landscape and environment quality improvement and cultural promotion to maintain an acceptable equilibrium between settlements and open spaces;
3. public policies aimed at fostering Peri-Urban agriculture and matching local organic food supply and demand.

The following paragraphs will provide some examples of these projects.

14.2 Grassroots Initiatives to Increase Awareness in Food Consumers and Producers

Fondazione Cariplo launched several projects on local food chains, food education and local initiatives related to the food and food production. The most relevant ones are:

- "Nutrire Milano" (Feeding Milan; 2011–2014), implemented by Slow Food Italia, in collaboration with the Polytechnic of Milan and the University of Gastronomic Sciences of Pollenzo. Goals of this project were to promote sustainable agriculture in Peri-Urban areas and to build a sound relationship

between PASM and the city of Milan, in both cultural and commercial terms. New specific services were designed and carried out, such as Mercato della Terra[1] (the first open air farmer market in Milan to sell short chain organic and local products).

- "Filiere agroalimentari sostenibili" (Sustainable agro-food chains; 2011–2014) implemented by the association Forum Cooperazione e Tecnologia[2] (FCT) of Milan. The team promoted a variety of activities, such as web tools development for GAS, support to small municipalities for vegetable gardens management and sustainable cultivation and the development of a local bread chain using ancient varieties of cereals (11 "grani antichi").
- "Nutrire la città che cambia"[3] (Feeding the evolving city; 2013–2015) developed by Associazione Solidarietà e Sviluppo (ASES) in collaboration with CIA (an Italian Farmers Association) and the University of Milan (Department of Agrarian Studies). The project focus on the fresh food demanded by different foreign communities living in Milano (specific vegetables usually imported) and has already launched tests has been in several farms of the Milan area in order to grow and provide fresh and good quality food to foreign communities, thus decreasing also long-distance imports and their environmental impact.

Singles grassroots initiatives may not grow enough to develop a sound and long lasting system. In order to sustain these initiatives giving a national and international visibility, Fondazione Cariplo organized conferences: an International annual meeting called Metropoli agricole[4] has been promoted by Fondazione Cariplo since 2013 in Milan to provide scientific background and institutional acknowledgment.

14.3 Landscape and Environment Quality Improvement

Interventions in landscape and environment improvement and cultural promotion of rural areas around cities are particularly useful to halt urban sprawl and maintain an acceptable equilibrium between settlements and open spaces.

Two significant projects were funded within this framework.

- The first one is related to bike tourism and specifically to the promotion of bike circuits in the area west of Milan close to the EXPO 2015 site, called "LET-Landscape Expo Tours".[5] Associazione Interessi Metropolitani (AIM) of Milan designed and implemented three LETs have been designed and

[1] http://www.mercatidellaterra.com/welcome.lasso.

[2] http://www.forumct.it/it/progetti/.

[3] http://www.ciamilano.it/new/nutrire-la-citta-che-cambia/.

[4] http://www.fondazionecariplo.it/it/news/ambiente/metropoli-agricole-come-rinnovare-l-agricoltura-e-i-servizi-citta-campagna.html.

[5] http://www.let-milano.com/en/progetto/.

implemented so far by Associazione Interessi Metropolitani (AIM) of Milan: "LET 1-Ville storiche e Groane", "LET3-Arte storia e agricoltura", "LET4-Terre d'acqua e cascine", with the aim of promoting rural landscape, parks, waterways and the architectural patrimony scattered around Milan countryside.

- The second one is related to a specific call for proposals that Fondazione Cariplo launched to protect and promote open areas around cities in the period 2010–2013, supporting both feasibility studies and intervention implementation. One of the supported projects is called "Strada del riso"[6] (Rice road; 2011–2015) and it involves an area of 650 ha included in the territory of the municipality of Milan where rice is still cultivated. In this place the association Parco delle Risaie designed and carried out several environmental interventions with new hedges and plants, and developed an agri-cultural path, consisting in an open-air museum where all the phases of rice growth and production can be observed.

These kinds of activities stimulate people's identification with their territory and boost their willingness to protect rural landscape and Peri-Urban agriculture from urbanization.

14.4 Tools for Public Policies

Several activities were carried out in order to orientate public policies to strengthen the relationship between urban and countryside and highlight the activities/polices on which the municipal administrations have a direct influence on (e.g. tenders' requirements for food in school canteens, regulations for farmers' markets).

University of Milan (Department of Agrarian Studies) is the leader of the project "Bioregione"[7] (Organic Region; 2011–2015), a very extensive project acting on the whole Lombardy Region. The project promotes sustainable local development strategies through the analysis of food supply and demand at regional and provincial level. Both the conventional and the organic production of vegetables, fruit and meat in Lombardy was mapped and compared with the demand. A specific focus was dedicated to map the key actors of institutional catering and quantify market opportunities for organic food potentially requested by school and hospital canteens and the specific gaps between supply and demand at provincial level. The results of the project are being used in the analyses for the Food Policy of the city of Milan,[8] described hereinafter.

In July 2014, the Municipality of Milan and Fondazione Cariplo signed an agreement aimed at developing the city's Food Policy on a five-year term.

[6] http://www.parcodellerisaie.it/it/; http://www.spaziaperti.fondazionecariplo.it/public/spaziaperti/progetti/2#description.

[7] http://www.fupress.net/index.php/SdT/article/viewFile/14336/13330.

[8] http://www.foodpolicymilano.org/en/.

The objective was to improve several food cycle aspects (namely production, distribution, consumption, waste prevention and waste management) and coordinate all policies dealing with these topics from different perspectives (e.g. community, social welfare, education, environment, well-being and international relations).

Milan's path to the adoption of its Food Policy has been structured in four stages:

1. Analysis of the strengths and weaknesses of Milan's food system: an assessment on the context and dynamics of the city food and agricultural system has been carried out through the collection of data, information and indicators on activities and fluxes directly or indirectly related to food.
2. Public consultation: Milan citizenry and diverse stakeholders have been actively involved through engagement platforms both on and off-line and a public town meeting has also been organised in order to present and discuss guidelines and objectives of the Food Policy.
3. Approval from municipal institutions: the document has been approved by the City Council of the Municipality of Milan.
4. Pilot projects: for each of the thematic fields identified during the analysis, a Food Mall, i.e. a planning panel with the participation of the main players/stakeholders identified, has been started.

14.5 Conclusions

Foundations such as Fondazione Cariplo have played, and will continue to play a key role in developing a more vital relationship between rural and urban areas by fostering the consolidation of grassroots citizens' movements and their collaboration with scientific institutions, as well as a more structured communication and promotion of their activities. The inclusion of several relevant issues in public policies can be fundamental to boost environmental and social positive effects.

Chapter 15
Between City and Countryside: Changing Nexus in the Urban Phenomenon of Rome

Benedetta Di Donato, Aurora Cavallo, Rossella Guadagno and Davide Marino

Abstract A lack of productive urban land, existence of food insecurity, an uncontrolled urban growth, lack of stable local food markets, land use conflicts in urban areas and a general lack of knowledge about urban and Peri-Urban food production, all join to fuel debate about cities and food in a time of change. Referring to the Mediterranean geography, cities do not originate from the countryside, but rather it is the countryside that originates from a city that it is barely capable of feeding. The settlement models that largely define the forms and processes of the farming and environmental systems to which they belong characterize the territorial dynamics of the Mediterranean urban areas. Looking at agri-food systems, even at a local level the aspects that have to be considered are: market variability and the price of raw materials, how these reflect on food prices definition, access to natural resources and the level of urbanisation. This work starts by analysing the relationship between city and countryside, to then reinterpret the current day context of Rome through factors that outline and define such a relationship. The relationship between food and cities—seen not as a simple fact but as a complex system of social, economic and political behaviour—can tell the story

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of many Mediterranean cities and certainly that of Rome. This is because the agricultural and urban facets of Rome are set side by side, without interruption, defining a breadth, a space that somehow epitomises the Roman landscape itself.

15.1 Introduction

The processes of exchange between urban agricultural systems, producers and consumer models are a recently emerging topic, in part due to the increased demand for high quality food over the last ten years or so. In reality, the concept of high quality food is linked directly to sustainable production and development systems that meet the new principles of ethical choice.

In this perspective, the consumer has an active role, and is more than the simple counter-part of those who produce and sell. The consumer is now nearly their ally, and a co-producer in this hybridisation of roles that is transforming the relational networks within local agri-food systems (Cavallo and Marino 2013).

However, over the last decade, consumption seems to have moved towards more sustainable models, and, from the late 1990s onwards, local provenance of agricultural produce is seen as a more sustainable solution (Feenstra 1997; Barham 2005). This approach encompasses all the questions linked to re-localisation of production with the aim of reconnecting food provenance and origin with geographical and organisational proximity (Aubry and Kebir 2013). If environmentally, socially and economically innovative agri-food systems are given the central role, two interesting aspects emerge. The first is connected to the process of re-writing behaviour: food is no longer a need but an opportunity for social and cultural exchange and, indeed, food is connected to markets, places that embody community life and are the quintessential public spaces in modern cities. The second aspect looks at the relationship with land and landscape. Demand for high quality food is implicitly a demand for land and landscape. Foodscape as a concept involves flows and processes, behaviour and places, social costumes and new forms and functions within the urban landscape (Morgan and Sonnino 2010); within city foodscapes as a concept a key role is played by the local food system. Interest in short, or local, food supply chains (SFSCs) has been rapidly emerging in recent years, together with a wide range of various interpretations (Renting et al. 2003; Sonnino and Marsden 2006; King et al. 2010; Fondse et al. 2012).

In this paper, taking Rome as our reference, we will then try to analyse the processes linked to food and then define its characteristics through the lens of city agri-food local systems.

The paper is organised as follow: Sect. 15.2 focus on the Mediterranean urban model and its features, Sect. 15.3 analyses the role of agriculture and local food in Rome. Finally some brief conclusions are provided.

15.2 Agriculture and Food in Mediterranean Urban Phenomenon

The urban zones of the Mediterranean area are the historical nodes of an exchange system that goes beyond the borders of the individual nations in which they are located. Echoing Braudel (1986), we can describe the Mediterranean as a succession of seas and a succession of cities. We will therefore look at the individual aspects that form the model for Mediterranean cities. Is Rome a Mediterranean city? If we think that it is unacceptable to reduce urban variety, such as the social-economical and historical-cultural aspects of its southern and northern shores, to a single model or pattern, can we identify common processes that stimulate the urban transformations taking place within Mediterranean urban areas? Despite the fragmentation of Mediterranean urban realities and their economic and social state, it is necessary to emphasise the existence of Mediterranean cities represented by the role played by food in defining the identity of Mediterranean urban phenomenon.

Several features emerge in this framework that differentiate Mediterranean environments from those of the continent as a whole. As highlighted by Salvati et al. (2012), an analysis of Mediterranean cities captures the contrast between a more mature urban model, typical of the Northern shoreline—despite not being completely balanced or morphologically compact—and a more spontaneous and largely disorganised archaic model, associated to the Southern shoreline, whose structures are only apparent in regions with greater history, politics and settlements. In these Mediterranean areas, from the early 20th century onwards, urban growth has concentrated in large and medium-sized cities, in tendentially more compact forms. Following a dynamic process, cities first experienced overcrowding in central areas, caused by the increase in population, and, later on, in the city outskirts. This was succeeded by a period of densification in the urban fringe, still relatively close to the city centre, with city planning chasing housing growth in the recurrent trend apparent in the urban areas of Lisbon, Barcelona, Marseille, Naples, Athens, Thessaloniki, Istanbul and, to a lesser degree, of many other cities situated on the northern shores of the Mediterranean.

While the informal expansion of human settlements is typical of the Mediterranean model (Leontidou 1990; Pace 2002; Minca 2003; Salvati 2011), it is clearly also both cause and effect of feeble planning, that is, the role of local institutions and decision-making plans, in governing the land transformation processes. As Pace (2002) most effectively states, planning chases rather than directs expansion. This is the second reoccurring characteristic of Mediterranean cities.

The third aspect concerns the compact urban form of Mediterranean cities compared to the more dispersed structure of the continental European model. This has the direct consequence of establishing a very distinctive relationship between city and countryside, with the countryside helping to determine the city landscape and vice versa. This leads to the fourth factor, that is, the relationship between city and countryside.

Referring to the Mediterranean geography, Braudel (1986) stated that the cities do not originate from the countryside, but rather it is the countryside that originates from a city that it is barely capable of feeding. The territorial dynamics of the Mediterranean landscape, even after nearly half a century, are still those described by the author, and indeed it is these settlement models that largely define the forms and processes of the farming and environmental systems to which they belong. However, the modern urban phenomenon in part negates the traditional idea of a city where the countryside has a place outside the "walls", and whose forms and functions are nearly in conflict with those of the city.

On the other hand, the processes of transformation affecting the primary sector in urban and suburban environments reflect an agriculture that, where it survives the pressure from encroaching urban settlement, forms (and produces) new forms and functions, typically reconnected to the historical value of agriculture in and around the Mediterranean cities. Through diversification, various initiatives and sell on farm experiences, the structure on which production is based tries to satisfy an urban demand that is no longer exclusively that of food, but is also directed towards social and environmental needs, with significant benefits in terms of employment, added value and the role of education and culture. Alongside the transformations to the farming environment, further changes also affect a key role played by food provision in cities (Barthel et al. 2013) considering the urban food system as the chain of activities connecting food growing, processing, distribution, consumption. This is the setting of the fifth element, determining the convergence of Mediterranean cities to a common model. Food, because of its cultural and historical place in Mediterranean tradition, has a significant role in configurating the areas where exchanges takes place, which are, therefore, specific places for meeting and forming relationships within the public spaces of a city. Markets are such places, together with the function they bring to city squares and streets. Food consumption, in the shape, for example, of street food, backed by better weather patterns, is closely linked to Mediterranean urban behaviour. Together with the network of personal space, these aspects help to define complex city geographies of food and food flows, functional in terms of relationships and space, that can re-write not only the form of space, but also the types of behaviour that such space generates.

15.3 The Rome Foodscapes: An Introduction

The role played by the local food network in Rome is remarkable, particularly in case of farmers' market, SPG' and those linked to box schemes experiences have seen significant success (Marino and Ciactiello 2012). The increasing importance of Alternative and Local Food Networks is shown in the data: the 60 % of Rome municipalities farms sell directly (Istat 2012) it was registered an increase of +57 % Farmers' market at municipality level and of +64 % in Rome's province (2010/13) (Marino et al. 2013). The local food network behind agriculture in the city, within a number of integrated social agrarian cooperative, who represented an alternative

food production system and landmark for many initiatives carried out by the civil society, associations, cooperatives, volunteer and school sectors, community supported agriculture (CSA) initiatives. In the metropolitan area of Rome there are 71 Solidarity Purchased Group (SPG), the 18.5 % of farms are involved in directly selling initiatives. Regarding the public food service, one of the most important projects deserving to be presented is known as the Quality Revolution, concerned with school canteen service in Rome. In the last decade the concept of quality has been widely used to describe the dynamics that have been shaping the system of food and agriculture. Taking for granted the various local characteristics linked to specific social and economic conditions or to the role of cooperative organisations, and even to the sensitivities of the local institutional framework, it is worth underlining the function covered by several organisations representing agricultural interests, such as Coldiretti through the work of Campagna Amica, the Organic Producers' Association, NGOs, or citizence and consumer interests like the Slow Food organisation, which for years has been backing farmers' markets and many information campaigns.

In this sense, SFSC processes tend to overcome the distinction between, helped by the hybridisation of the role of consumers and producers, between public goods and private goods and become instead "local public goods" (Cavallo and Marino 2013). This network identifies the capacity of SFCS initiatives of building places (Augé 1992). Human territorial space is inscribed with "rules of residence" that represent a content that is, at the same time, both spatial and social, whereby the quality of space depends upon the relationships that take place within it, also giving to the foodscapes infrastructure at the same time its feature of a physical (spatial) and relational value. The final point, in the case of Rome, is the value of historical and cultural aspects in interpreting the role of farming when defining the cultural character of a place. In the situation of Rome, we identified different types of agriculture and several morphologies of SFSC.

Traditional farming in Rome refers to intensive farming operations of different sizes, located along the coastal zones—on reclaimed land—which are mainly concerned with horticulture, including under glass, and dairy cattle. Where there are many production models, they also include arable crops, fodder and meadows. Traditional agriculture also features within Rome's Great Ring Road, with farms frequently being located in protected areas. In several cases, alongside traditional commercial channels targeting the Roman market, this type of farm also makes use of channels outside the region and short supply chains.

Mixed farming, which refers to operations in the Roman area combining different types of traditional farming functions. They are medium or large-sized and are distributed in a heterogeneous way. In this category, co-operative farms have a central role, with most being located on land reserved for agricultural use in order to halt urban expansion, and currently secured as protected natural areas. Farming is often organic, and involves mixed structures, with particular care to limit the impact of production on natural resources. While these operations were highly innovative in the 1970s, today they offer a mature innovation, significant in terms of employment (often they are co-operative associations of farm labourers) and

participation in short supply chain initiatives. The last type concerns the complex, yet lively, mosaic of small—and often tiny—farms of a social nature, aiming mainly at social inclusion and work integration. Social farming in Rome covers the various operations that involve disabled people, immigrants and children of various ages. The farming practices adopted here clearly vary in relation to their different forms, objectives and functions, acting as a tool to take benefit of the current food climate, in order to encourage a more sustainable production with greater accountability to consumers and with fair returns for producers.

15.4 Conclusions

The system described above configures the set of all the different forms of foodscape in Rome as a device of resilience for the city, made up of places where flows, relationships and processes become increasingly more sustainable, and where both physical and intangible spaces act as an infrastructure in their exchange with the city.

The relationship between food and cities—seen not as a simple fact but as a complex system of social, economic and political behaviour—can tell the story of many Mediterranean cities and certainly that of Rome. This is because the agricultural and urban facets of Rome are set side by side, without interruption, defining a breadth, a space that somehow epitomises the Roman landscape itself. While the relationship between the parts has not changed—the logic of Rome is still formed within the breadth between city and countryside—the questions asked by the new structural balance within the territory require fine-tuning to the capacity of examining and implementing in parallel the two aspects, the city and its surroundings, and new cognitive, interpretative and operative instruments must be constructed for this territory that is neither urban nor rural, but a complex synthesis of both.

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Chapter 16
Energy Systems and Water and Food Nexus

Marcello Magoni

Abstract The multiple relationships that characterize the FEW nexus in Peri-Urban areas have some very interesting specificity. This is because the Peri-Urban areas are located between rural areas, which are often rich in food, water and energy, and urban areas, which are the places where there are the greatest resource consumption, particularly of energy and food. Furthermore, the Peri-Urban areas are more easily transformable of urban areas, being less densely built and having less infrastructure, and therefore they are preferable to locate the power equipment of different types. The article shows the main relations and integration opportunities that exist between energy and water and between energy and food and indicates some strategies and actions to promote the integration of these three resources in Peri-Urban areas to improve the global efficiency and reach a more sustainable and resilient development.

16.1 Energy Systems and Peri-Urban Areas

The performance of a sustainable and resilient energy system is defined by its capacity to respond to the needs of a territory, starting from the energy demands both in quantitative and qualitative terms (Bazilian et al. 2011). From this point of view, Peri-Urban areas can play a significant role in meeting the energy demand of cities, where is consumed the most quantity of energy.

In fact, in the Peri-Urban areas the proximity between different land uses opens the field to various and greater opportunities of energy production and use. There are many possibilities in the use of local and non-local energy resources, mainly connected in a distributed generation network, that can promote the transition to

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energy systems able to guarantee high levels of sustainability and resilience, which also include security of supply and competitiveness in economic costs.

The most interesting element in this territorial relation is the heat generation and consumption. Cogeneration and waste-to-energy plants connected to a district heating system are the most relevant system from the point of view of the amount of thermal energy that can be produced in Peri-Urban areas for cities. Precisely, their location at the edge of urban areas is a matter of interest for the realization of these systems, being close enough to heat consumers to allow a convenient and efficient energy transmission and at the same time not affecting densely populated areas.

Starting from the approach of urban metabolism, which considers the energy flows as a main component, various tools and methods have been developed to analyze cities' energy consumption from the quantitative point of view in terms both of direct and indirect energy uses. Hereinafter, the main relationships between the energy, water and food flows are described and then some integrated intervention aimed at improving the efficiency of energy systems are briefly shown.

16.2 The Nexus with Water

The use of water for energy production is a factor found in almost all energy systems. We can distinguish two ways of water use for energy purposes other than hydroelectric and hydrothermal power plants (direct way).

In the first one, water is used in some of the phases of different energy supply chains, for the extraction and the refining of fossil fuels, as coolant in thermal power plants, as energy carrier for heat conveyance. Water is also a major factor in many innovative energy production technologies, from the biomass cultivation to the extraction of fossil fuels by unconventional techniques (hydraulic fracking for shale gas and oil extraction from tar sands) (WEF 2011; Olsson 2013). Other water-intensive technologies are the concentrated solar power and the cultivation of third generation biofuels, both often located in desert areas characterized by water scarcity (Hussey 2010).

In the second one, water is used in the processes aimed to build energy systems and in the extraction of the materials needed for their construction, in particular metals.

The consequences on water are different. Consumptive uses lead to a shortening of the water cycle and to a water shortage in the later stages, not-consumptive uses imply a withdrawal and a refund of equal amount, but thermal and chemical water pollution may partially or totally prevent further uses and have extensive and long-lasting consequences on the ecosystems (WEF 2011).

However, an intervention on the water cycle to change its natural course requires the use of energy. The water supply chain has a power consumption that is highly dependent on local conditions, but in general the pumping of groundwater and the desalination of sea water, as well as the wastewater treatments, require a significant

amount of energy (Hussey 2010). Furthermore, water energy costs for its transportation and, more generally, for the uses that require its handling are high.

Conversely, the energy intensity of the processes of water extraction and handling makes them a potential energy storage, in particular for the electricity from renewable sources that can be used for pumping or for the desalination when production exceeds the demand.

With regard to wastewater treatment plants, their combination with biogas production systems can cover and often exceed energy needs, making them an interesting example of energy production almost always located in Peri-Urban areas (EPA 2011).

16.3 The Nexus with Food

The most evident connection between agricultural production and energy is represented by the cultivation of biomasses for energy production. The use of biomass, although positive from the point of view of the reduction of greenhouse gas emissions, has generated some conflicts and trade-offs (UNEP 2011). The main conflict lies in the use of first generation biomass, for crops cultivated exclusively for energy purposes. This has led to competition for the use of agricultural land and water (but sometimes also natural land) between energy crops and food (Harvey and Pilgrim 2011). In addition, the removal of large areas of rainforest and the drying and subsequent oxidation/burning of peat bogs, in order to replace them with monocultures for biofuels (e.g. soya), are responsible for significant emissions of carbon dioxide and for the destruction of entire ecosystems.

The use of second-generation biofuels, and in particular the use of agricultural waste, is a virtuous example of integrated resource management, as the use of specific crops suitable for marginal lands, which have a high yield and a low demand for energy inputs, or the growth of crops that can use brackish water, unsuitable for food cultivations (UNEP 2011). Another virtuous practice is the use of agricultural land for the cultivation of a second crop in rotation with the main one, to be harvested during the months in which the land is usually left uncultivated.

Other forms of energy production that are spreading in agricultural areas, such as photovoltaic fields, tend to replace the existing crops, increasing energy production at the expense of agriculture. Another possible trade-off is in the management of hydroelectric dams, which determines the availability of water in the downstream areas: seasonal-based energy production has often conflicting demands with those of the agricultural irrigation that depends on the same basin.

The amount of energy required for agricultural production has been increasing at the same pace with the increase in productivity, mainly as a result of three factors: mechanization, irrigation and fertilization applied to ever larger cultivated areas (Olsson 2013). The spread of wealth implies an increasing consumption of the elements on a higher level in the food chain, which requires a higher energy input

per calories produced. In addition, the issue of food storage and transport and the related energy consumption becomes increasingly relevant with the increase of wealth.

16.4 Integrated Intervention in Peri-Urban Areas

To improve the effectiveness of interventions that consider multiple resources in an integrated view, the coordination between the various institutions and authorities is necessary to enact and enforce laws and regulations, define and implement policies and strategies, subsidize and license the use of the different resources (Hoff 2011).

The proximity to the city of a Peri-Urban area and consequently the limited costs for transportation allow many possibilities of the combined use of secondary resources that come both from urban and rural settings. Agricultural waste may be used to co-feed the waste to energy plants, as well as biomass commonly used to integrate other energy sources (including agricultural and agro-industrial by-products and manure) can enter the cycle of municipal wastewater treatment in plants that produce biogas by co-digestion. Similarly, some municipal waste (organic fraction and waste from the maintenance of green) can be combined with agricultural origin biomass in the rural plants for the production of biogas and biomethane.

In some cases, heat generation in industrial areas allows the exploitation of the related energy waste for agricultural use, starting from greenhouses. In addition, it is possible to recover the quantity of carbon dioxide needed for the so-called "carbon dioxide fertilization" in greenhouses from the heat generation and cogeneration plants.

The use of secondary resources for energy production, which often requires quantities not producible by a single farm or company, is leading to the formation of clusters and consortia. The biofuels production chain, which is de facto an industrial production that implies large plants, large quantities of raw material and the security of a steady supply, has been the first that required the drafting of plans for the whole productive districts. The district plans, conveniently laid out, can be a suitable tool to manage the resources in an integrated way also by providing monitoring actions over time.

Finally, to take into account the perspective of climate change we must consider both the changes in energy demands and the effects of energy production on the resources and sectors which are most vulnerable to those changes. On one hand Peri-Urban areas provide ecosystem services that may play a central role in the reduction of greenhouse gases emissions and in climate change mitigation, while on the other hand the adaptation actions that affect water and food are often energy-intensive. See for example the increase of artificial irrigation in the context of changing precipitation patterns and the need to provide water by pumping from aquifers or by desalinating sea water in the overall framework of scarcity determined by the retreat of glaciers.

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Chapter 17
Rethinking Energies in Peri-Urban Areas: Potentiality and Action Criteria

Eugenio Morello

Abstract Energy occurs on the territory in different forms and at different levels of quality. This paper investigates how the consideration and implementation of several manifestations of energies and in particular renewable energy sources (RES) can become a foundational design element for urban and regional planning. Specifically, an exploration of possible criteria for the optimal use of direct and indirect forms of energy to support their widespread on the territory is presented. According to this investigation, Peri-Urban areas of metropolitan cities offer the most interesting location for rethinking energy landscapes, mainly because of the availability of places to be retrofitted and the presence of cut-off areas by infrastructures. In fact, Peri-Urban areas always represented service areas for the city center and provide most of the challenges in order to be converted into resilient landscapes. A series of energy-conscious planning criteria for Peri-Urban areas are introduced.

17.1 Peri-Urban Areas as an Opportunity for Resilient Energy Landscapes

A conscious and mature exploitation of energy topics was currently not adequately investigated in the planning practice. Hence, a stronger integration of energy and urban planning is needed to consider energies[1] as a foundational design element for urban and regional planning. In fact, all the choices concerning energy strategies and actions have to consider the wide spectrum of the whole life cycle of material flows and try to reduce entropy at the local level as much as possible.

[1]The usage of the plural indicates the multiplicity of energy forms and qualities that can be addressed on the territory.

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Table 17.1 The relevance of Peri-Urban areas for the energy-conscious urban planning of metropolitan cities

Topic	Central urban areas	Peri-Urban areas	Rural areas
Availability of space	Scarce availability of space for implementing RES	*Availability of space for RES (green and brownfields)*	Availability of space for RES but eroding precious soil
Conservation of energy	Preservation of places and energy savings of the existing stock as a priority	*Occasion for retrofitting and place-making and substitution of the building stock*	Minor issues of preservation, retrofitting and new construction
Integration of RES	Investigating modalities of integration of RES	*Landscape design opportunities*	Landscape design opportunities
Activation of energy and eco-cycles	Scarce opportunities on the existing building stock	*Virtuous energy and eco-cycles enabled by conservation and production strategies together*	Virtuous energy and eco-cycles easier in the presence of large natural resources
Sustainable mobility scenarios	The compact city positively impacts on sustainable mobility scenarios (sharing policies and public transport)	*Fragmented population and irregular built density limits sustainable mobility scenarios*	Low density will promote solutions for private sustainable mobility (electric vehicles)
	Proximity to city center ←	Ecosystem services	

Peri-Urban areas offer a great opportunity for redesigning cityscapes, if compared to central urban areas and rural areas (Table 17.1). Moreover, rethinking Peri-Urban areas is one of the most urgent challenges for planners. In fact, environmental sustainability solutions have been explored and put in place both for the compact urban tissues and the rural areas, but solutions for hybrid territories at the fringe of cities are mostly lacking.

In particular, Peri-Urban areas present the following opportunities for improving energy strategies: (i) energy generation: the availability of space for the implementation of clean energy solutions and ecosystem services in proximity of the city center; (ii) energy savings: the occasion for retrofitting and substituting the existing building stock, which is mostly of little value; (iii) energy self-sufficiency: fragmented urban tissues require re-aggregation strategies that could possibly promote the development of independent energy eco-islands, following the urban ecology principles of closing energy and eco-cycles on site towards the self-sufficient city.

One of the most difficult and significant energy aspects to tackle in Peri-Urban areas is mobility. The fragmented population and the irregular distribution of built density highly affect sustainable mobility scenarios. We are in-between a compact

environment that enables sharing policies and public transport on one side, and a low density rural territory which will move towards private electric mobility solutions on the other side. Hence, for Peri-Urban areas, we cannot assume generally.

17.1.1 Energy Planning Criteria for Action on Peri-Urban Areas

Orienting the strategic energy planning of Peri-Urban areas represents an opportunity to approach the redesign of the territory based on a more holistic vision. In fact, energy transition requires a novel understanding of space, flows and lifestyle of people according to urban ecology principles. A number of criteria are explored as follows.

Firstly, the strong link existing between space and energy, i.e. the spatial dimension of energy and in particular production from RES, calls for a more effective integration of energy planning and urban planning (Droege 2008, 2012). For instance, renewable energy strategies offer different opportunities depending on the available urban patterns on the territory. For instance, high and low density urban areas of the same territory catch in average the same quantity of solar irradiation on roofs, but the ratio of roof surface to population differs, and consequently the rate of coverage of renewable energy to the total energy demand (Carneiro et al. 2009). Another opportunity that makes RES an option is the large presence and concentration of underused land, like waiting lands (brownfields or empty spaces undergoing transformation in the short term), cut-off areas from infrastructure (typically roundabouts and buffer areas), large impervious areas (parking lots, roofs, large mobility infrastructures like railroads). If these types of land use cover a significant part of the territory, then RES can become a feasible strategy. Therefore, linking urban form, environmental quality and energy indicators is crucial.

Secondly, mapping local energy demand and potential on site production is a crucial operation for a reasonable planning of feasible energy scenarios (Sijmons et al. 2014). Hence, the quantification of space and energy represents an unavoidable step. For instance, the availability of large natural resources for biomass production, or the presence of farms for biogas production can be taken into account only if the scaling-up of energy generation is feasible from both and economical and an environmental point of view. Of course, the rational transport of materials represents a key factor for promoting local cycles.

Thirdly, not only the production of energy (active strategies), but also passive strategies have to be taken into account (Table 17.2): thermal gains represent indeed both an opportunity (savings through passive architecture principles) and a threat (urban heat island formation) (Givoni 1998; Littlefair 1998; Littlefair et al. 2000).

Table 17.2 Solar city designed by active and passive strategies

Active strategies	Passive strategies
The sun for producing electricity and thermal energy through solar modules Urban form requirements: – Maximal solar exposure of horizontal and vertical surfaces – Hence, minimum skyline roughness of the cityscape to avoid mutual shadowing by buildings ⇩ Conflicts between urban resilience and urban energy policies may arise: e.g. extensive PV panels installations on roofs instead of green roof construction can impact on urban thermal comfort and storm water management thus increasing vulnerability	Controlling the incoming solar energy and thermal gains for passive architecture and thermal comfort in open areas Taking into account the thermal properties of solar energy, e.g. the urban heat island Providing open spaces with high levels of thermal comfort contributes to: – reduce urban energy needs because of (i) the reduced thermal load on buildings; (ii) the increase of open space usage; – Support sustainable mobility patterns At the building scale and urban block design, maximizing the solar exposure of southern facades and reducing loads on east and west orientations (summer)
Both aspects relevant for energy-conscious urban planning	

Fourthly, following an urban ecology approach to planning (Alberti 2008), the city is intended as an ecosystem where the different parts should collaborate to create an energy and environmental balance. Therefore, activating virtuous energy cycles on site by recognizing synergies among urban patterns represents a paradigm shift in planning human settlements and land use at the large scale. 'Second-law thinking' is an emergent concept in energy-conscious urban planning (Stremke and Koh 2010; Van den Dobbelsteen et al. 2011). Hence, energy givers and energy receivers can be identified on the territory and linked in order to reduce the energy cycles. For instance, heat cascading is a virtuous example whereby wasted heat from industry (energy giver) can be reused by housing (energy receiver) through a local district heating plant. Energy is not dispersed, and entropy is minimized.

Finally, even if relevant, energy strategies towards self-sufficiency are not the only aspect to be addressed in order to achieve a truly sustainable territory. If investigated from a strong life cycle thinking perspective, we have to question what is the most sustainable and efficient usage of space and resources. In fact, the compatibility of energy-related actions to other nexus have to be taken into account. For instance, energy actions can generate conflicts and hinder complementary environmental strategies, thus limiting the general target of reducing the environmental footprint and achieving a resilient city at the same time. The typical example for this conflict is represented by the application of renewable energy solutions like solar parks: even if clean and only partially anchored on the terrain, these can

hinder a more sustainable use of land and the growth of vegetation, thus impoverishing the quality of the natural resources of the soil in the long term. Similarly, the use of agricultural land for biomass or biofuel production instead of food production can be less sustainable if investigated from a strong life cycle thinking perspective.

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Chapter 18
Strategies to Reduce the Use of Fossil Fuels in the Lombardy Region

Mauro Alberti and Mauro Brolis

Abstract The Regional Energy and Environmental Programme (REEP) is the planning instrument adopted by the Lombardy Region to define how to reach the commitments set by the European Union for 2020. The actions are designed to achieve the 2020 goals for competitiveness and sustainable development. They consist in the objectives for renewable energy sources set by national legislation and in the new framework for energy efficiency measures provided by the Directive 2012/27/EC. The reduction of energy consumption, the optimal exploitation of renewable resources and the strengthening of the security of the regional energy system are the main levers of change that the REEP will activate. Besides, renewable energy sources and energy efficiency represent a fundamental opportunity for revitalizing the economic and productive system of Lombardy, while promoting a real green economy. The envisaged measures aim to promote the modernization and efficiency of the supply infrastructure and to maximize the storage and delivery capacity, both for power and natural gas (or bio-methane). The actions and projects included in the REEP are based on an extensive and long-established knowledge of energy systems down to the local level, i.e. the demand and the supply by energy carrier, infrastructures for energy generation, distribution and use, actual and potential use of renewable energy sources, specific information on key targeted sectors, such as buildings (Lombardy has developed a buildings energy performance cadastre and a heating and cooling systems cadastre).

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18.1 The Regional Energy and Environmental Planning

The Regional Energy and Environmental Programme[1] (REEP) is the planning instrument adopted by the Lombardy Region to define how to reach the commitments set by the European Union for 2020. The reduction of energy consumption, the optimal exploitation of renewable resources and the strengthening of the security of the regional energy system are the main levers of change that the new regional energy planning instrument will activate.

The REEP considers five main strategic objectives:

- to develop infrastructures and systems for large-scale production of energy, such as new hydro-power capacity but also enhanced policies and new governance models, e.g. for the development of public accessible charging stations for electric vehicles;
- to develop a distributed generation of energy, with particular reference to the deployment of efficient and clean renewable energy technologies for thermal uses, e.g. heat pumps technologies and high-efficiency biomass combustion technologies, to be included in the regional heating and cooling systems cadastre for a better monitoring of performances;
- to maximize the potential of energy savings in end-use sectors;
- to improve the energy efficiency of processes and products;
- to promote high-quality supply chains for energy sustainability, i.e. an industrial supply chain that can permit to achieve a green growth, even in terms of internationalization opportunities.

The main target of the REEP, consistently with the increase of the share of renewable energy and the reduction of GHG emissions, is the decrease of use of energy from fossil fuels, by sharing responsibilities among the various concerned sectors (residential, commercial/services, industry, and agriculture).

Besides, some key enabling factors are considered, such as the support for research and innovation for the development of new technologies, strengthening the recourse to the ESCo (Energy Service Company) model, the activation of innovative financial instruments, the control and strengthening of implementation measures through monitoring and accounting, communication, awareness-raising and involvement of users (Public Administration, businesses and citizens).

Thus, five strategic lines have been identified:

1. the development of large-scale projects: district heating, smart grids and smart cities, efficient street lighting networks and broadband networks;
2. the economic levers and financial instruments: EU structural and investment funds, guarantee funds for ESCos, revolving funds, (project and equity) and bonds;

[1] http://www.energialombardia.eu/programmazione_energetica.

3. the innovation as an engine for development: research and development, business clusters, new supply chains/enterprise networks and patenting;
4. the regulation-based modernisation: sectorial rules and simplification;
5. a stronger relationships with the territory: guidance and support for municipalities (in particular for the effective implementation of the Covenant of Mayors initiative), for businesses and for households and consumers.

18.1.1 Sharing of Responsibilities for Energy Saving

The objective set in the REEP may be achieved only by involving all key actors responsible for energy uses at regional level, i.e. citizens and households, businesses, trade associations, cooperatives and social operators.

Nonetheless, sharing of responsibilities has to be stimulated by removing barriers and by enhancing those factors that allow a more effective implementation of energy efficiency actions (see Fig. 18.1).

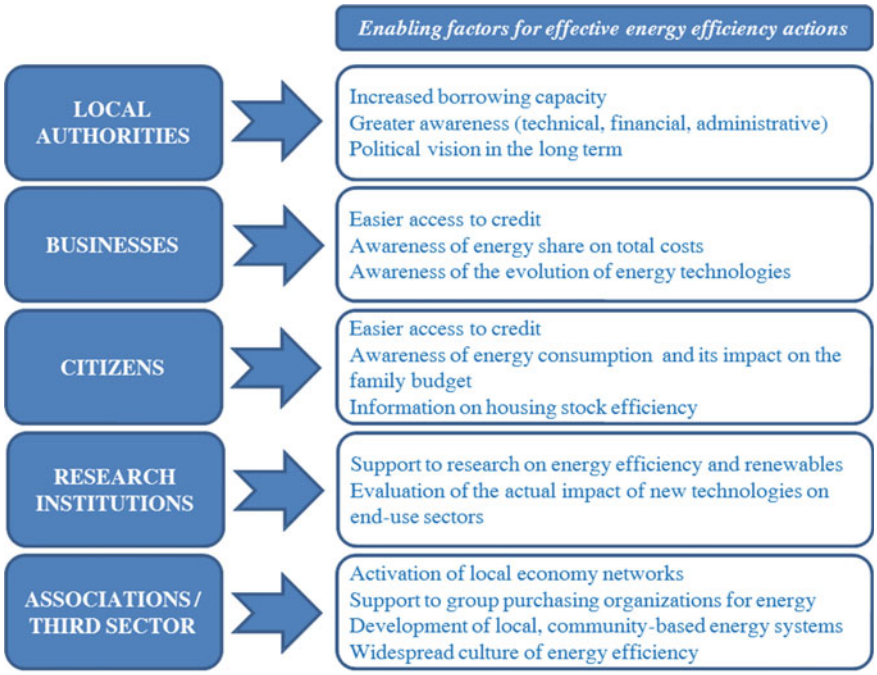

Fig. 18.1 A simplified scheme of enabling factors for energy efficiency by different stakeholders as defined in the REEP

18.1.2 Scenarios and Measures

The sustainability scenarios assessed within the regional planning have been elaborated considering a "reference scenario", according to which, by in 2020 in Lombardy 25.6 million of final energy (toe) are assumed to be consumed for final uses.

The REEP aims at achieving a strong reduction in fossil-based energy consumption, by means of cost-optimal actions in different target sectors.

The foreseen action in the Plan and expected results in terms of energy savings are reported in Table 18.1, with reference to two different scenarios, characterised by different levels of penetration of the measures.

The high-sustainability scenario would guarantee a 10.6 % reduction in energy consumption, whereas the medium-sustainability scenario would bring a 6.8 % reduction.

After the approval of the REEP, a continuous monitoring of energy data is essential to help understanding how effectively the actions are being implemented. Regional energy information systems (see Sect. 18.2) can represent a crucial tool to share information at different scales, to engage stakeholders and to periodically reshape policies and programs so that expected results are achieved.

Table 18.1 Expected energy savings from planned measures in different scenarios in the REEP (energy unit: ktoe)

Sectors	High scenario	Medium scenario
Residential and commercial properties	**1740**	**1167**
Nearly-Zero-Energy Building legislation	80	70
Private housing efficiency (regional financing—fiscal measures—energy management—heating systems control)	1090	720
District heating network efficiency	120	80
Tertiary sector (efficiency criteria in authorization procedures—regional calls for energy efficiency)	450	297
Public housing (residential and tertiary) and lighting efficiency	65	40
Industry	**500**	**330**
Knowledge support for energy assessment	100	65
Production system efficiency (regional calls for energy efficiency, management systems, white certificates)	400	265
Transport	**400**	**200**
Electric mobility	95	41
Transport system efficiency (regulatory standards—non-technological actions—enhancing public transport)	305	160
Total	**2705**	**1737**

18.2 The Regional Information Systems for Monitoring Energy Performances

The Lombardy Region has created and manages various information systems that provide a continuous monitoring of the energy performances in different sectors to regional and also national and European stakeholders.

The SIRENA20 (Energy and Environmental Regional Information) System[2] was founded in 2007 with the specific aim of monitoring the whole energy chain in Lombardy, from generation to use in different sectors, information which is crucial for the competitiveness and environmental sustainability of the energy system in a broad sense. The system provides all the information, down to the municipal level and with respect to all the energy carriers and all the final use sectors and includes a specific focus on renewable energy generation.

Other important contributions are given by the systems that support administrative and control procedures in the energy sector, such as energy certification of buildings,[3] maintenance, control and inspection of heating systems,[4] and low-enthalpy geothermal installations.[5] The data loaded into these registers are publicly available for consultation and have also been published as Open Data.[6]

18.2.1 SIRENA20 and the Support to Local Energy Planning

SIRENA20 was developed by involving[7] three different Italian regions (Lombardy, Basilicata and Sicily) to share information and define a common methodology and data structure (database) for the regular collection and organization of relevant energy data which are needed for energy planning so that data analysis tools are available for regional and local authorities (see Fig. 18.2).

SIRENA20 allows portraying the state of the regional energy system in any specific year, by building a "regional energy balance". The energy balance is generally expressed in form of a matrix showing supply, conversion and consumption figures for energy sources within a national economy or an economic area over a defined period and in a form which is as comprehensive and detailed as possible. SIRENA20 elaborates data down to the municipal level. These data are particularly important for municipalities that intend to contribute to the achievement

[2] http://sirena20.energialombardia.eu/factor20/.

[3] www.cened.it.

[4] www.curit.it.

[5] www.rinnovabililombardia.it.

[6] www.dati.lombardia.it.

[7] www.factor20.it.

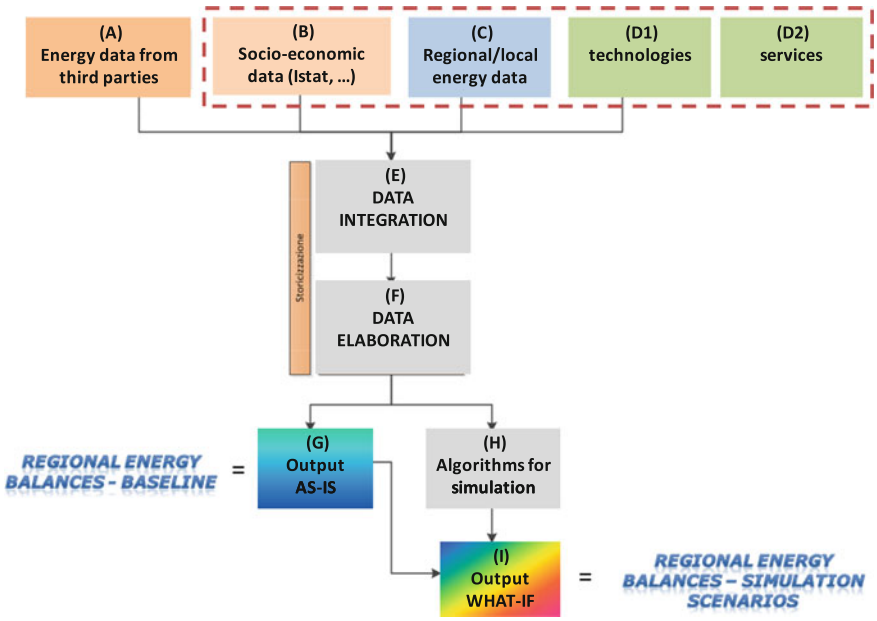

Fig. 18.2 The conceptual model of the SIRENA20 system

of 2020 objectives, as required by the Regional policies that promote a sharing of responsibilities among all administrative levels. In Lombardy, in the last five years more than 800 municipalities have adhered to the Covenant of Mayors initiative in order to develop a Sustainable Energy Action Plan (SEAP) and so to reduce CO_2 emissions by at least 20 % by 2020.

The information provided by SIRENA20, the other regional energy information systems and other tools developed by the Region[8] allow municipalities (and provinces) to carry out the whole process of sustainable energy initiatives. The steps include the definition of the baseline consumption, the setting of targets, the definition of priorities, the ex-ante evaluation of sustainability energy actions, the continuous monitoring and benchmarking of indicators. Specific support is then provided to municipalities to identify suitable financing mechanisms to implement the actions, with particular attention to low-cost financing for investment with long pay-back periods (e.g. deep retrofitting of public buildings).[9]

[8]See note 7.

[9]As a result of the joint activities in Factor20 and in the Covenant of Mayors initiative, the Province of Bergamo has submitted a programme (FABER, to be financed within the ELENA assistance programme by the European Investment Bank) to implement energy efficiency measures in about 120 municipalities and 400 buildings, in the next 3–5 years.

Fig. 18.3 Trend of energy demand per unit of space for new buildings in Lombardy

18.2.2 The Regional Energy Efficiency Databases

Since 2007 the Lombardy Region has developed information systems to support administrative and control procedures related to energy efficiency in buildings. Three systems are currently managed, whose data are organised in databases and are publicly available for consultation:

- the Regional Energy Cadastre of Buildings, which contains more than 1.5 million certificates;
- the Regional Cadastre for Heating and Cooling Systems, which contains more than 3 million records;
- the Regional Registry Low-Enthalpy Geothermal Installations, which contains more than 700 records.

By managing all this information, Lombardy has been able to continuously improve its policies and programs for energy efficiency so to achieve significant results in terms of key performance indicators, e.g. as regards specific energy demand of buildings (see Fig. 18.3).

Chapter 19
The Bioregion and Eco-efficiency

Gianni Scudo and Matteo Clementi

Abstract This paper introduces the bioregion concept and describes territorial metabolic flows tools useful to identify and evaluate strategies and appropriate actions to increase the eco-efficiency of local systems. Global agro-food system contributes about 30% of Global Heating Gasses (GHG) emission (Lang et al. in Food Policy—Integrating Health, Environment and Society. Oxford University Press, 2009) due mainly to long distance transport and detail purchasing by car. Bioregional approach (Sale in Dwellers in the land: The bioregional vision. Sierra Club Books, 1985; Fanfani and Saragosa in Il Progetto Sostenibile 29, 2011), promotes transcalar regional supply and demand chains where food and energy are grown, produced, sold and consumed within a certain territorial unit. The intensive use of locally available renewable resources reduces drastically the use of non-renewable resources increasing eco- efficiency of local systems in term of Non Renewable primary Energy/Renewable primary Energy ratio (NRE/RE in MJ) and reducing environmental impact (for instance CO_2eq emissions). In accordance with the bioregional paradigm, the methodology Ecodynamic Land Register (ELaR) is used to assess the self-sufficiency achievement of trans scalar territorial systems—from the municipal to larger areas scales.

19.1 Introduction

In this paper we define a "bioregion" as the land required to achieve food and energy supply self-sufficiency over the long term and we describe how to use support tools to develop locally appropriate self–sufficiency strategies.

These strategies will be a consistent part of an experimental ("ad hoc" defined) planning tool called Food and Energy Integrated Plan—FEIP.

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The aim of FEIP is to promote integrated local agro-food and energy systems able to give self-sufficiency in food and a contribution to meet the energy demand for housing, transport and services, while providing anyway an adequate income from agriculture practices.

In this experimental phase, which focuses on territory analysis and scenarios development tools implementation, a small territorial system has been chosen: the Albairate municipality in Milan Metropolitan Area, within the Agricultural Park of South Milan (PASM).

Nevertheless the optimum scale for local self-sufficiency effective strategies is generally more extensive: Metropolitan Area or Region.

ELaR[1] aims to highlight and rethink energy and materials flows which feed people's activities through analysis carried out by open-source Geographic Information Systems (GIS) (Clementi 2008; Clementi and Scudo 2009). It highlights the dynamic relations between energy and matter demand and local renewable potential which should necessarily be maintained in equilibrium in a self-sufficient system. The local demand for energy and materials analyses the consumption categories of housing, food and marginally of private transport; data are expressed in terms of general amount referred to the local context or in terms of per capita data.

The method is articulated in the following processing phases:

1. Locally defined territorial boundaries identification;
2. Renewable Local Energy Potential assessment—Analysis of contextual conditions and local renewable energy potential;
3. Local Energy-Matter Demand and Supply for residential, agricultural/food consumption and private transport activities assessment. Aggregated impacts quantification through the environmental impact indicators (Global Warming Potential GWP100 CO_2 eq emissions, NRE/RE MJ non-renewable and renewable primary energy);
4. Local self-sufficiency scenarios assessment based on best practices transfer, filtered on the basis of local factors mapped on the GIS (climate, use, existing buildings shape and technology, and local agriculture practices).

Good practices effectiveness evaluation is carried out through specific tools (resources/impact geographies and "user histograms"). They are used to verify the proposed choices by calculating the local energy and materials demands through three specific indicators and related reference thresholds:

[1]The ELaR methodology is currently being applied in two specific cases study. The first one is the research "Bioregione" funded by Fondazione Cariplo, which proposes different scenarios to match public procurement local catering demand (school and hospitals, …) with potential Lombardy region agricultural production supply (Caputo et al. 2014). The second is the application of the ELaR methodology in Albairate, a small settlement nearby Milano (Scudo et al. 2014). The aim is to draw up an initial prototype of "Food and Energy Integrated plan" (FEIP) starting from the formulation of self-sufficiency scenarios. The data presented briefly in the text show a possible example of local food and energy supply self-sufficiency.

- Accounting productive land demand compared with the locally available land;
- Accounting CO_2 emissions per capita, compared with reference value of sustainability (in a range between 1000 and the 2000 kg CO_2 eq/person*year);
- Accounting primary renewable and non-renewable energy consumption, compared with threshold values, borrowed from the 2000 W-Society program (www.2000watt.ch): 1500 W from renewable sources and 500 W from not renewable ones.

The elaboration and communication of the results are provided by two basic tools: Resources/impacts geographies and User histograms.

19.2 Resources/Impacts Geographies

Resources and impacts geographies are obtained by collecting on the same territorial support information on Local Demand of Energy and Matter (LDEM), and on the Renewable Energy Technical Potential (RETP).

Information on LDEM is collected in the form of impact geographies, while information on RETP are collected as resources geographies related to local supply.

The first tool (impacts geographies), represent the supply chains of production and consumption through geo-referenced vectors which locate supply chain different nodes (Fig. 19.1). Two different indicators quantify the environmental impacts associated to the different nodes of the supply chain:

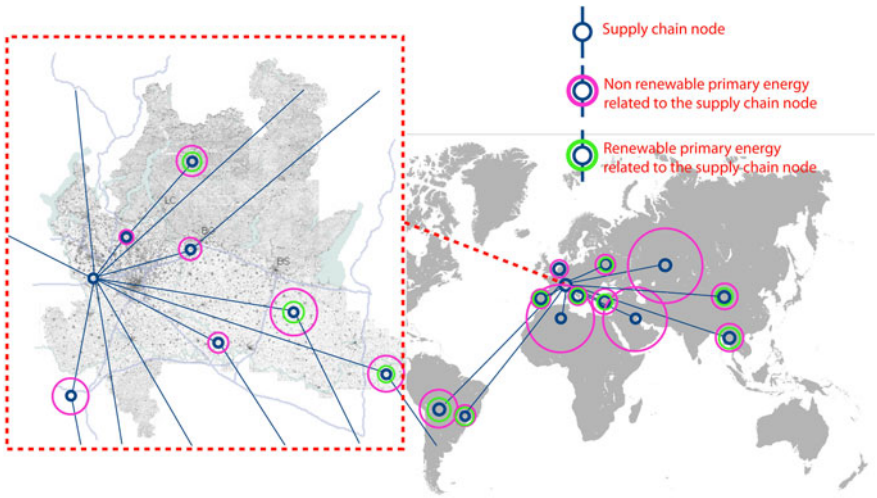

Fig. 19.1 Geographies of the impacts associated with the consumption of primary energy, concerning the Local Demand of Energy and Matter (LDEM) in Albairate

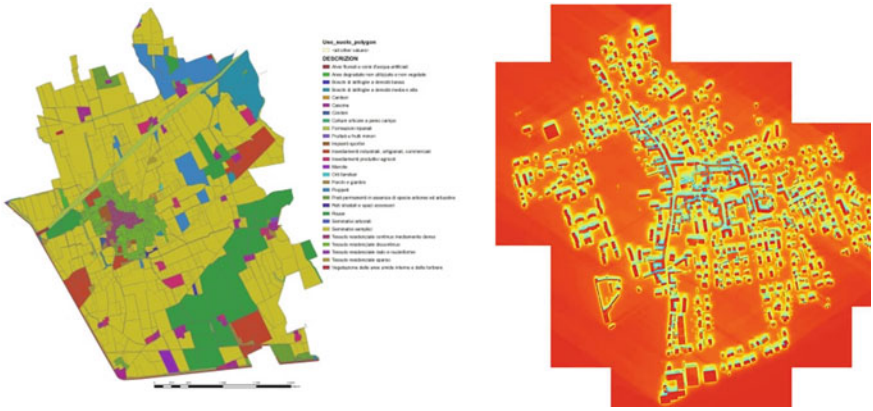

Fig. 19.2 Some maps that make up the resources geographies of Albairate (Lombardy region), to the *left* a land use map, to the *right* a solar radiation map

- the use of primary non-renewable/renewable energy sources, expressed in MJ equivalent;
- accounting of CO_2 equivalent emissions, expressed in kg of CO_2eq.

The second tool (resources geographies) is obtained by collecting in specific thematic maps quantitative data related to the locally available renewable resources. Once defined the boundaries of the local context, this phase of the methodology processes and stores in the same GIS data on local physical and biological/agricultural environment. This data-base provides descriptive information on the climatic conditions (solar potential mapping at different scales, pluviometric conditions, windiness, humidity and air temperature throughout the year), on actual land uses, on geo morphological aspects, etc. (Fig 19.2). The main goal of such a data archive is to provide useful information to identify the current local renewable potential supply and develop possible local sustainable scenarios for good practices transferability.

Good practices transferability depends on the assessment of similarity between territories under analysis and good practices territories. This information, as part of one single GIS, can be associated to different portions of land, as example a cadastral land or urban parcel.

The association of such information to geometric particles using GIS, enables identifying the vocational characteristics of local territory portions.

Geo-referenced information allows to use GIS to carry out assessments at different scales, from the whole local context, to portions of it or to individual particles (buildings or land parcel).

19.3 User Histograms

The user histograms build the connecting structure between the information collected in the geographies, in order to check different design choices. They report in terms of per-capita flows local energy and matter demand and relate them with the extension of productive land per-capita. Histogram general structure can be easily understood looking at the following diagrams.

As shown by the arrows (Fig. 19.3), the histogram describes energy and matter flows direction from the right to the left. Consequently, the right-hand side of the histogram contains information on the resources supply (RETP locally available), where information on local renewable supplies are given. The left-hand side shows information about LDEM.

The central part houses strategies as possible design choices in between local renewable energy/matter supply and demand (Local Self-sufficiency Scenario—LSS). They perform the main function to connect local demand and supply.

The image below (Fig. 19.4) shows an example of user histogram describing the main components. The extreme left of the graph shows data of energy and matter demand expressed in terms of the adopted indicators, in this case the CO_2 equivalent emissions. The quantities of energy and materials are aggregated into the consumption categories of housing, food and, marginally, of private transport, to compose the total amount of energy and impact (NRE, GWP 100) per person (on the extreme left). Such option gives the possibility to compare the data with reference threshold values per person (15,800 MJ of primary non-renewable energy—NRE per year as sustainability goal suggested by the 2000 W Society program, and between 1000 and 2000 kg of CO_2 per year—GWP100).

The right part of the graph represents the local renewable supply; it shows the extension of the productive surfaces in the local context, expressed in square meters per person. The productive surfaces are intended to be the productive portions of land for agriculture and forestry, as well as the built-up portions that show relevant features such as high solar vocation surfaces.

The far right part of the histogram brings together the extensions of productive land per capita identifying the amount of productive land available. The different colors refer to the extension of productive land available per person (darker color) and the extension of the available productive land interested by the application of good practices assumed in the scenario (Fig. 19.4).

The structure of information allows in the design phase to operate a useful and immediate comparison between productive land necessary to local self-sufficiency

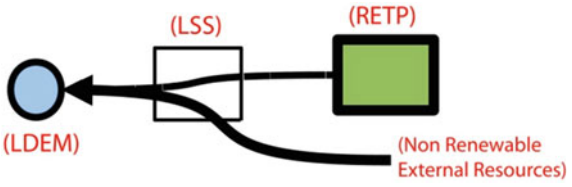

Fig. 19.3 General synthetic structure of a user histogram

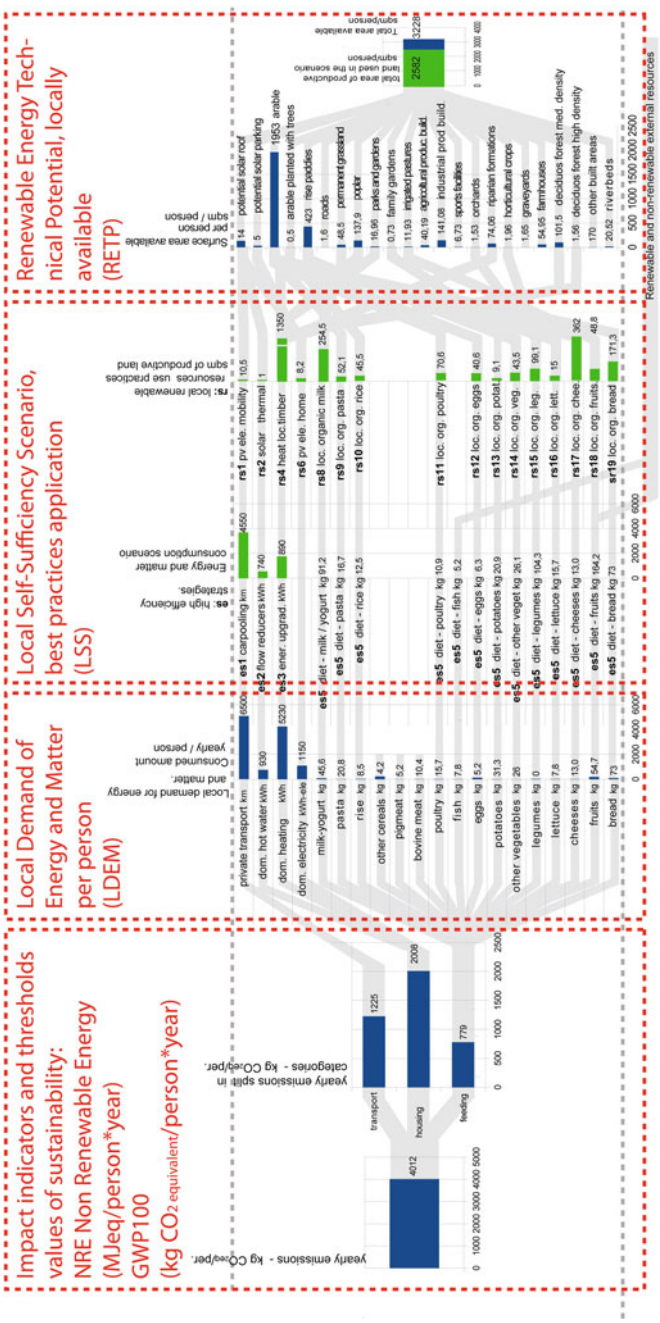

Fig. 19.4 Example of user histogram describing the main components

and land actually available. Such condition of immediate comparison drives the design choices among the good practices, in order to find out the ones more suitable to the real conditions of the territory.

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Chapter 20
Fourth Generation District Heating: Potentials and Planning Challenges of an Urban Energy Infrastructure

Chiara Cortinovis

Abstract This paper deals with the planning issues arising from the development of 4th generation district heating and cooling systems, also known as *low temperature district heating*. This emerging technology has already demonstrated its efficiency and cost-effectiveness and shows the potential to sustain the energy transition of the urban thermal sector to the 100 % renewable era. The most relevant aspects that characterize low temperature district heating as a promising planning strategy to support the transition to more sustainable and resilient urban energy systems are presented and discussed. The possibility of integrating a wide variety of flows from different thermal sources and the shift towards a more distributed model of energy production make low temperature district heating an effective strategy to increase the share of renewables, to value all the sources on the territory, and to strengthen virtuous nexus between different parts of the city. Planning processes should therefore find suitable tools to support and promote district heating and cooling as an integrated part of smart urban energy grids.

20.1 The Evolution of District Heating Technology

The provision and distribution of thermal energy inside cities by means of infrastructures at the urban or the neighbourhood scale has always been a challenge for planning, distance being the most relevant factor in defining the feasibility of thermal networks. District heating and cooling (DHC) has been developing since the late nineteenth century, when the first system to deliver water steam to the southern part of Manhattan was built. Since then, different solutions with the purpose of transferring thermal energy have been applied and have marked the evolution from the first to the third generation, the most common in today's cities (Lund et al. 2014). In the last years, the development of these technologies led to the "fourth generation

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networks", the so-called "low temperature district heating", whose potential role in the energy transition of the thermal sector is by now widely recognized at different institutional levels, including also the EU (Connolly et al. 2014).

Although these solutions have been deeply studied from the technical point of view, and applied in some pilot cases, mostly new urban districts characterized by low energy demand,[1] the vision of the territory that this kind of networks can foster and support, and the many implications for planning, have been scarcely highlighted. Keeping this point of view, the paper deals with the most relevant aspects that make low temperature district heating an integrated infrastructure able to support the transition to more sustainable and resilient urban energy systems.

20.2 The Fourth Generation of District Heating and Cooling

One of the main characteristics of the fourth generation is the possibility of integrating a wide variety of thermal sources, including residual heat and renewable production. This last consists of a broad spectrum that ranges from biomass to solar thermal, heat pumps, deep geothermal and others, whose contributions become relevant when the network works at a lower temperature compared to traditional networks (Lund et al. 2014). Through DHC, thermal energy can therefore be provided with low or zero carbon emissions also in medium- and high-density neighbourhoods, where individual renewable plants are not feasible or insufficient to meet the demand, or should be avoided to preserve valuable urban landscapes.

Another important aspect, strictly related to the first one, concerns the shift towards a distributed model of production. The general scheme of the system consists of one or more large plants, which make use of sources and technologies not applicable to small scale—typically waste-to-energy plants or biomass and biogas combined heat and power (CHP) plants—located in Peri-Urban areas (Eriksson et al. 2007). The network, fueled by these systems, is able to collect along its way all the heat flows produced inside urban areas by factories (Fang et al. 2013) as well as by household plants, and use them to keep the temperature of the carrier fluid adequate to the need of the system, thus increasing the maximum delivery distance. Then, the resulting grid is a combination of a centralized model and a distributed model whose rate increases with the lowering of the operating temperature. By this way, DHC becomes an urban energy infrastructure able, as the electricity grid does, to collect the various production on the territory and to

[1]Some of the most renown cases are Lystrup (Denmark), where a new low temperature network has been successfully connected to the existing DH grid; Okotoks (Canada), where 90 % of the space heat demand of 52 houses is met by solar thermal energy; Greenwatt Way in Slough (UK), which combines biomass, solar thermal and heat pumps, demonstrating that Zero Carbon can be achieved through DH.

redistribute the heat to individual users, no longer just consumers but *prosumers* of energy (Rezaie and Rosen 2012).

As a consequence of the supply model, some features related to the spatial arrangement of DHC systems can be highlighted. Peri-Urban and suburban areas are convenient locations for the main plants thanks to their proximity to the city and to the small distance that the network has to cover. The replacement of household boilers and the relocation of thermal plants outside the dense city causes not only a net reduction of greenhouse gases and particulates emissions but also, when the cooling potential of DHC networks is exploited, a reduction of the urban heat island effect due to the thermal emissions of air conditioning systems. Moreover, DHC can make use of the thermal production of CHP plants, which is often wasted: their location in Peri-Urban areas is an opportunity for combining flows of by-products and wastes from both the rural and the urban areas.

20.3 Toward Sustainable and Resilient Urban Energy Systems

From this brief description, many of the characteristics that are expected from future energy systems (ECF 2010) emerge in relation to fourth generation DHC. First of all its sustainability, as a result of the integration of many different sources. The exploitation of renewable energy ensures a general benefit in terms of reduction of greenhouse gases emissions, while the use of residual heat and the application of the principle of energy cascade increases the metabolic efficiency of the city. The strict link between renewable energy and energy security in the age of peak oil has already been highlighted (Valentine 2011). The predominance of a distributed production model leads to a higher reliability in comparison to a centralized one, because the loss of one producer can be easily faced and single traits of the network can be made independent if needed (Alanne and Saari 2006). Moreover, the diversification of sources reduces the dependency on each of them and contributes to increase reliability (Li 2005). The possibility of integrating different suppliers and expanding progressively the network demonstrates the flexibility of this system and thus its resilience as an infrastructure.

Low temperature DHC has therefore the potential to become an integrated part of smart energy systems, able to increase the territorial efficiency by exploiting all the non-fossil thermal sources spread on the territory and to build synergies between the different parts of the city as well as virtuous nexus between the resources.

Technical issues have limited the implementation of this technology inside the existing city, in particular inside the historical and high-density districts. Because of the need for considerable infrastructural works in the set-up phase, even though the components are lighter and less expensive compared to that of the traditional DHC

networks, low temperature DHC spreading and development is associated more to the building of new neighbourhoods than to the renovation of existing ones.

However, it is for the latter that the connection to a fourth generation DHC can provide the best results both for single users, being in that condition a more affordable and reliable solution than other renewable-based thermal plants, and for the urban environment as a whole in terms of microclimate and air quality. Starting from this perspective, challenges for the development of low temperature grids mainly lay on planning: their integration with existing networks and their extension together with the progressive refurbishment and replacement of the built environment inside the city should be supported by adequate institutional, financial and community engagement tools.

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