Chapter 11
Innovation as Transformation: Integrating the Socio-ecological Perspectives of Resilience and Sustainability

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11.1 Introduction: The Social and Epistemic Contexts of Resilience and Sustainability

Innovation, the creation of new technologies in the spheres of knowledge use, business, policy or natural resource management, is a highly context-dependent and institutionally steered process. A paradox of innovation can be formulated as: innovation is both a cause for our current unsustainable trajectory and a hope for tipping in new more resilient and sustainable directions. Practically seen innovations are used to solve specific problems. These problems, especially environmental problems, are often of complex nature and require the integration of the technical innovation process itself with the political, economic or civil society action of many actors, institutions or social groups. Therefore, a technical innovation becomes, when it is applied, part of social innovations. The social processes of development and change show the main problems of innovations in natural resource management and environmental policies: the innovations require change or transformation of social behaviour of certain social groups and actors with different interests and aims. Because of the significance of the social components of innovation processes, we ask: What kind of behaviour changes and social transformation do environmental problems—that are today global, consequences of global environmental and social change—require? When innovation becomes part of overarching processes of problem solving and social change, it can be said, innovation becomes (part of) social

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H. Pinto et al. (eds.), *Resilience and Regional Dynamics*, Advances in Spatial Science, https://doi.org/10.1007/978-3-319-95135-5_11

transformation. In the case of environmental problems that have an impact on social and ecological systems simultaneously, the important context factors of innovation and change are resilience and sustainability, themselves complex processes of change.

The concepts of resilience and sustainability exist in different and incompatible versions in ecological research—as complementary or as contrasting concepts. The controversial discussion of the concepts requires their interpretation before they can be used in social or ecological research. Our interpretation of resilience and sustainability in the broader framework of coupled social-ecological systems (SES) is compatible with a widespread use, but competing interpretations exist. SES are theoretically conceptualised in social ecology (Fischer Kowalski and Haberl 2007; Bruckmeier 2013, 2016) as interconnected systems where ecological or social-ecological resilience means basically a capacity to adapt to disturbance (Folke 2006). Sustainability is, in contrast to resilience, seen as a more long-term process of transformation of SES that requires beyond adaptation to disturbance a capacity to initiate and maintain over long periods of time, decades or centuries a process of directed change. Such long periods cannot be planned and managed, but require further, more complex modes of steering and governance that allow to influence indirectly complex social and ecological processes that cannot be planned for—this is the real challenge of transformation towards sustainable resource use in modern society.

In the research on transition and transformation in recent years (for a summarising discussion see Markard et al. 2012), the criterion of sustainability is seen as that of changing the processes of exponential economic growth and growth of resource use, reducing them, ideally seen to zero growth. However, in the broad sustainability discourse after the Brundtland report from 1987, where sustainability was seen as intra- and inter-generational solidarity of resource use, no exact criteria have been agreed upon; the ideas of zero-growth or degrowth remain controversial up to now. Ideas of degrowth find support from ecological research (see the "limits to growth"—reports of the Club of Rome; Asara et al. 2015), but less from economic or other social research, where continuing growth is seen as compatible with environmental goals when simultaneously mechanisms to reduce pollution and degradation of ecosystems, are implemented, for example, in policies of ecological modernisation (Mol et al. 2009).

The integration of the two perspectives of resilience seen as adaptive process (to cope with disturbance) and sustainability as transformative process (to achieve a balanced interaction of social and ecological system components), aims at a broader, interdisciplinary and integrated perspective of innovation and adaptation than possible with the single concept of resilience. Clarifying the concepts of resilience and sustainability requires some further concepts that are connected to the use of both, especially that of risk and vulnerability.

11.2 Reframing Innovation: Connections Between Risks, Vulnerability, Resilience and Sustainability

1. Risk was since its origins in the economic and technical sciences a formal, probabilistic and calculable term in the sense of the probability of a negative event/consequence of action. This is specified in the classical term of risk in economics by Knight (1921) as outcomes of action for which insurance is possible, whereas uncertainty refers to outcomes of action for which no insurance possible. With the sociological risk research, especially by Beck (theory of risk society, 1986) and Luhmann (1991) in late twentieth century, risks are studied in a broader social context and as risks in new forms that cannot be formulated with the classical risk concept which refers to individual or organisational decisions. The concept of systemic risks which is described by Renn and Klinke (2004); it converges with Becks conceptualisation of risks that are non-calculable and require the analysis of the functioning and interactions of large-scale social and ecological systems. Some of these risks cannot be perceived (e.g., nuclear radiation), known only from science. Three variants of risk analysis can be differentiated in epistemological terms (Diekmann and Preisendörfer 2001: 58):

   – Realist variants: risk analysis of engineers where objectivity of risks is defined through probability of negative outcomes and quantity of damage;
   – Constructivist variants: cultural theory of risks of Douglas and Wildavsky: members of different cultures perceive/interpret risks differently, which implies that it is difficult or impossible to achieve a common understanding;
   – Variants in-between realist and constructivist, where risks include as well constructivist as objectivist components, culturally specific subjective and social perceptions of risks and dangers that exist objectively, thus understanding risks as real and as constructed phenomena. This seems adequate for many forms of environmental and systemic risks that are identified through science and research, but are perceived and interpreted differently by individuals or social groups, according to their knowledge, values, and interests.

2. Vulnerability can be understood as exposure to risks and dangers; risk and vulnerability seem concepts depending on each other. Vulnerability implies a broadening of risk analyses, as caused by social or ecological factors or disturbances. It means primarily social vulnerability. The vulnerable subjects are humans. Also when vulnerability is differentiated for biophysical and social systems (Füssel 2007), as caused by disturbances in natural or social systems, it remains in both cases social or human vulnerability, as highlighted in the review by Lundgren and Jonsson (2012). They discuss (referring to Cutter et al. 2003) social vulnerability through natural hazards or climate change, as dependent upon:

   – "Lack of access to resources (monetary, information, knowledge or technology)
   – Limited access to political power and representation

- Social capital (including social networks)
- Beliefs and customs
- Building stock and age
- Frail and physically limited individuals
- Type and density of infrastructure and lifelines".

Social variables important for vulnerability to climate change are seen as age, gender, race and socio-economic status (Lundgren and Jonsson 2012: 3).

The extension of the vulnerability concept to imply vulnerability of ecosystems or of the global social and ecological systems maintains the metaphorical connotation of vulnerability as a health related term; it remains a term that receives scientific and theoretical meaning more from that of risk, from which it develops. Resilience, in difference to vulnerability, is not referring to social actors, groups or communities; its theoretical meanings are derived from the functions of ecosystems or coupled social and ecological systems—more a system capacity than an action capacity.

3. For the further development of the resilience concept (Bruckmeier and Olsson 2014) two variants of resilience of ecosystems need to be discussed:

   - Resilience as maintaining or regaining stability after disturbance (engineering resilience), and
   - Resilience as capacity to absorb disturbance through shifts to other equilibrium states without collapsing (ecological resilience).

The second version of resilience can be broadened to include more complex types of coupled social and ecological systems (Folke et al. 2005; Folke 2006). With the broadening of the resilience concept to social system components, the meanings of resilience change further. Social and ecological forms of resilience are not parallel phenomena, but may imply contradicting requirements of maintaining social structures and functions or ecosystem functions (Adger 2000). Lloyd et al. (2013) specify social components of resilience in the notion of social-ecological resilience as capacity that implies social and transformative learning of social actors to support the restructuring of a SES in response to turbulence or catastrophes. In this sense the elastic concept of resilience that does not necessarily require the capacity of action and anticipation of humans, but can be based on simpler capacities of behaviour change, gains a clear social meaning. Social or collective learning is a core capacity for resilience and adaptation and for sustainability and transformation.

Connecting vulnerability and resilience analysis, with resilience as a capacity of social or ecological systems to cope with disturbance without collapsing, requires for coupled social and ecological systems (SES) the identification of strategies to enhance social-ecological resilience: These strategies can be:

- Strategies to reduce vulnerability through analysis of disturbance (identifying main disturbances for an area or social community), identifying crucial vulnerabilities through vulnerability assessment, mitigating vulnerability (through measures for reducing exposure to hazards and disturbance or compensating for their effects), reducing sensitivity (minimising responsiveness to changes through

disturbance), institutional development (building and developing institutional capacity to prepare for disturbances and minimise their impacts), and trajectory management (oriented to projected changes relevant for future development: Chapin III et al. 2009);
– Strategies to enhance the adaptive capacity of the SES, e.g., fostering diversity, stabilising feedbacks and creative renewal, learning to live with change and uncertainty, adapting institutions and governance to changing conditions environmental conditions, building participatory and deliberative, developing multilevel governance through adaptive management or governance.

4. Sustainability is the most complicated and contested term used here. It implies in difference to resilience the maintenance of long-term development capacity of SES that cannot be reduced to the management of disturbance and crises. It implies, beyond resilience capacities, to cope with the limited availability of natural resources and redistribution of resources between users. Connections of different spatial and temporal scales are effective in the capacities of SES to achieve sustainability. In recent years has, after a long and often controversial debate of sustainability in science and policy, developed a new perspective that connects sustainability with the scientifically elaborated concept of socio-ecological transformation. This re-interpretation of sustainability (Bruckmeier and Olsson 2014) is used in the following analysis.

The challenges of transformation where the components of resilience and sustainability interact can be described in terms of three combined concepts and processes of *innovation* (Leach et al. 2012), *adaptation* (Armitage and Plummer 2010), and *transformation* (Raskin et al. 2010). These terms mark the complexity of processes of socio-ecological and socio-cultural transformation that cannot be reduced to political processes, although the "governance of sustainability" and its operational components such as "transformative action groups" are key components. Sustainability transformation or transition requires governance strategies for indirectly influencing the complex processes that work slowly and over long time, such as certain processes in ecosystems, or population growth and demographic transition. Incremental changes are not sufficient to cope with the prevailing challenges we face in several domains (energy production, water supply, pollution, greenhouse gas emissions, nuclear risks, extreme weather events); necessary are "long-term, multidimensional, and fundamental transformation processes" (Markard et al. 2012: 956). Fischer-Kowalski and Rotmans (2009) discuss different, micro- and macroscopic approaches to socio-ecological transition or transformation. Smith et al. (2005) describe four different strategies of transition that show the varying contexts of transition management in the governance of sustainability: endogenous renewal; re-orientation of trajectories; emergent transformation and purposive transitions.

Governance of sustainability requires, finally, a social-ecological theory of transformation that systematizes the analysis of spatio-temporal dynamics in coupled SES: an interdisciplinary theory that can be connected with empirical research and

other theories, for example, theories of innovations. The dynamics of resilience and sustainability in SES can be summarised as:

– Adaption in a shorter temporal perspective where the reaction to disturbance and maintenance of balance and system boundaries after disturbance are the basic criteria (a dynamic derived from the functional mechanisms of ecosystems), and
– Transformation in a longer temporal perspective where the capacity of a whole society to change its systemic structures in coherence with the requirements of maintaining functioning ecosystems (a dynamic derived from the structures and processes of societal systems).

11.2.1 The Challenges: Connecting Analyses of Risk, Vulnerability, Resilience and Sustainability

Connecting risk, vulnerability, resilience and sustainability analyses is rarely done in one comprehensive system analysis of SES. For such an integrated analysis that can be done in several and separate parts, a series of decisions about the interpretation and application of the terms needs to be made, for which no exclusive support through scientific knowledge can be claimed. The notions discussed here—risk, vulnerability, resilience, sustainability—are elastic, have plural and competing meanings, and no consensus is available for their interpretation and application. The forms of such sustainability syntheses differ, but all of them have several common components. In difference to the widespread use of the resilience concept, for example by the "Resilience Alliance" and the Stockholm Resilience Centre, where also the interpretation of sustainability is dominated by the meaning of resilience as adaptation (adaptive cycles, as formulated in ecological research, Gunderson and Holling 2002), the conceptual and knowledge syntheses of the kind we discuss are based on the core concepts of transition or transformation.

The management of transition to sustainability is confronted with threefold transformation challenges:

1. Social challenges of rural-urban development in metropolitan areas: Processes of urbanisation happen today rapidly and are often badly managed, causing new social imbalances, inequity and poverty. The dimensions of megacities with many million inhabitants make cities less and less manageable. Cities are vulnerable through climate change and have increasing problems of food security. Mobility in form of migration or commuting to cities has become the dominant process in many countries. Increasing re-migration to the countryside indicates a crisis in urban development which requires new, integrated strategies of local development. Combined strategies of resilience and sustainability do not only require technical innovations and technologies, but social innovations that are created, for example, by transformation action groups and help to solve problems of social and environmental change.

2. Methodological challenges of "the city without boundaries": The administrative boundaries of cities are no longer effective for sustainable governance. Cities stretch through their resource use in the surrounding rural areas and far beyond—through the global flows, exchange and trade of resources they are becoming global in the sense that are dependent in their natural resource use from global flows of energy, matter and information. The global stretching of cities can be measured in the land and the resources they use beyond their boundaries. In local transformation strategies this global interdependence through resource flows needs to be reduced to create local opportunities for resilience and sustainability that support simultaneously the transformation at national and global levels. Resilience and sustainability require new ways to deal with the planetary boundaries of resource use at local levels, e.g., using methods and indicators as ecological footprint analyses of cities, material and energy flow accounting (MEFA), human appropriation of net primary production (HANPP) of ecosystems, energy return on input (EROI) in production and resource use processes.
3. Conceptual challenges—"the resilience and sustainability paradoxes": Resilience and sustainability are "essentially contested concepts" (Collier et al. 2006), defined and interpreted in many different ways. They became overused and over-interpreted, give no compass and guidance for sustainable transformations. The future sustainable society is unknown and has to be built with knowledge developed and experience gained in the transformation processes. At this point of navigating society into an unknown future innovation processes become "strategic variables": transformation implies social, cultural, technical and technological, economic, and political innovation. Transformation needs to be constructed anew, with measurable concepts for which the ideas of resilience and sustainability require re-interpretation with new knowledge and conditions of global change that affect local development. For cities, a paradox can be specified in the idea of the urban sustainability multiplier by Rees: cities do not have ecological disadvantages only, also a series of advantages that help to save material, energy, space and using resources effectively.

With this description of the nexus of resilience and sustainability, the interpretation of *resilience has the focus on adaptation (adaptive cycles)* and that of *sustainability implies the transformation of social-ecological systems* of modern society. Beyond adaptation to climate change and disturbances, sustainability requires a long-term, future-oriented perspective of development and collective action, resulting in changes in the interactions between social and ecological systems, the core processes determining sustainability. We illustrate combined forms of resilience and sustainability analyses with studies from rural and urban areas in European research projects.

11.2.2 Integration of Resilience and Sustainability Analyses in Studies of Rural–Urban Interaction

1. *Resilience related to agricultural production:* Agro-ecosystems and agricultural SES as our model cases are examples of interacting social and ecological systems. Beyond the basic meaning of resilience as adaptation to disturbance and system or boundary maintenance under conditions of stress, three types of resilience can be differentiated for these system types:

   – Ecosystem resilience advanced from studies of ecological resilience (Cabell and Oelofse 2012) to include ecosystem services or benefits provided by ecosystems to humans (Paavola and Hubacek 2013). Also alternative forms of agriculture, organic farming or community based agriculture, where the connection between ecosystems and people or resource users is emphasized (King 2008) can be understood as enhancing ecosystem resilience.
   – Livelihood resilience refers to people as part of SES. Rural livelihood studies have been carried out in great number and manifold perspectives, also regarding the connections between vulnerability, resilience and sustainability. Local livelihood studies

   > "may miss out on long-term shifts which will, in time, undermine livelihoods in more fundamental ways. Long-term temperature rises may make agriculture impossible, shifts in terms of trade may undermine the competitiveness of local production or migration of labour to urban areas may eliminate certain livelihood options in the long-term. . . . Sustainability and resilience thus cannot always emerge through local adaptation in conditions of extreme vulnerability." (Scoones 2009: 19).

   – Climate resilience refers to global climate change and its consequences for agriculture, especially in the Global South where the majority of agricultural producers are (poor) smallholders.

With these concretisations of the resilience terminology, resilience analyses can be developed as an interim step of sustainability analyses: resilience is one of the manifold processes to deal with in strategies of sustainability governance. Studies of rural-urban development and interaction—where it is necessary to connect a variety of social and economic development dynamics of different kind—show that resilience and sustainability require a systematic reconstruction of the system-maintaining processes in social and ecological systems which became especially complex with the continuing globalisations of economic and natural resource management processes.

2. *Rural-urban interaction in late modern societies—the consequences of globalisation:* In local strategies for rural development that is closely connected to metropolitan areas (for example, in the forms of peri-urban and urban agriculture, in metropolitan areas and their surroundings) we can study how the transformation processes unfold their dynamics in reaction to social and ecological change.

It is characteristic for such areas that a variety of specific development processes that unfolded their own dynamics in the course of history and modernisation, are interlinked, overlapping and overlaying. These development processes include:

- Rural development, closely connected to agriculture, forestry, fishery and the change of landscape through agriculture and agro-ecosystems (into cultural landscapes);
- Urban development, closely connected to industrial production, trade and commerce, administration and governance, resulting in further changes of landscapes from cultural to "techno-landscapes";
- Local (community) development that becomes connected to global development through the processes of globalisation, technical communication and action over distance;
- Population growth and demographic change processes;
- Modernisation and economic growth as societal dynamics directing development in modern society;
- Technological change and its interaction with social change processes;
- Environmental degradation and overuse of natural resources from local to global levels.

To connect complex processes in an integrated perspective that enables the formulation of strategies of sustainability governance, the regime concept is a widely used theoretical term (Holz et al. 2005). The relevant regime studies for SES include the forms of social-technical regimes (Smith et al. 2005) and socio-metabolic regimes referring to natural resource use (Krausmann et al. 2009). With the help of the mediating concept of social and ecological regimes, the abstract terms of resilience and sustainability can be translated in concrete forms of transition management that combine (in locally specific forms) the processes of

- Innovation (as creating knowledge and technologies to solve specific problems in SES and in the use of natural resources),
- Adaptation (as capacity of SES to cope with disturbance, for which innovation is a precondition), and
- Transformation (as capacity of SES, initiated by global environmental governance, to maintain long-term transformation of social and ecological systems).

Transition management in the long process of rural-urban transformation towards sustainability requires a permanent search for new possibilities and new models of development and change, for building capacities of (continuously more effective) adaptation and transformation that learn from the weaknesses of former approaches. Metropolitan areas, growing rapidly into mega-cities with many millions of inhabitants, experience worldwide similar difficulties in their efforts to transition management and local sustainable development that started after the Rio-conference in 1992. The transformation is more complicated than expected, requires long-term

perspectives, new visions and social innovations, better integration of rural and urban development, new forms of cooperation of actors with different interests in transformation action groups, greater efforts and more human, social and knowledge resources than imagined. The real challenges are only gradually perceived by the actors that include governmental and non-governmental organisations, when global change affects the local development processes: for example through deterioration of the environmental conditions for agriculture or urban development through global climate change.

11.2.3 The Social and Methodological Challenges of Rural–Urban Interaction

Vulnerability studies for urban and peri-urban areas, including food security and climate change, are mainly from non-European countries, showing the practical significance of this kind of analysis as related to policies of development cooperation. The situation in Europe is specific with regard to the late phase of modernisation and post-industrial development in most countries. This has as consequence a broadening of the functions of peri-urban agriculture and land use beyond food production, including

> "the conservation of heritage landscapes, the conservation of water resources and farmland resources, and providing for both leisure and tourism activities. Anything that renders peri-urban agriculture difficult may also undermine the ability of agricultural land to support these other functions. . .. climate change and variability are likely to alter the capacity of these peri-urban agricultural territories to continue supporting these various functions" (Bryant et al. 2013: 60).

The multifunctionality of peri-urban agriculture can be described further through the following functions described by Zasada (2012):

- *Agricultural land-use in peri-urban areas* "contributes to the quality of life in urban regions, as it fulfils broad ranges of functions and services to the nearby urban areas".
- These functions include "food production as well as the provision of recreational services and other services related to the management of the cultural landscape, which in turn contribute to the ecological capacity of the landscape".
- *Peri-urban agriculture has two specific components*, "an intensified, high-value production on the one hand, and extensified, lifestyle and environmental-driven land-use on the other".
- *Further characteristics of peri-urban agriculture* include "(h)igh-income revenues, small-scale farm structures and the parallelism of horticulture and grassland cultivation".

- *From the perspective of farmers and land-owners* "the opportunities attached to the peri-urban framework conditions outweigh the disadvantages, which have encouraged them to adopt activities that valorise the urban demand potential".
- *In terms of planning and policy requirements* for the development of peri-urban agriculture "the main fields of action are the preservation of farmland and encouragement of multifunctional land-use, the strengthening of urban-rural relationships and the enhanced consideration and targeting of agriculture" (Zasada 2012: xiv).

The description above results from a comparison of agricultural land-use in peri-urban areas in several European countries. It does not yet show the differentiation of transition strategies and the challenges of the continuing urbanisation process and the social challenges of resilience and sustainability. Examples from case studies by this author and from other European research projects show that land use is under continuous pressure to develop innovative ideas, to adapt to social and environmental change, and to build strategies for transformation to sustainability. These strategies require experimenting and social learning from the experiences made with land use change.

The *methodological challenges* of peri-urban agriculture as part of sustainable transitions can be described as that of developing new criteria for measurement and indicators in local development in the complex processes of natural resource use that connect local and global flows of resources. These challenges are not discussed further here. We mention only some important examples for methodological tools in transition management: ecological footprints (Wackernagel and Rees 1996) to measure the land areas required for human consumption of natural resources; material and energy flow accounting (MEFA: Haberl et al. 2004) to measure the global resource flows and their inequalities; human appropriation of net primary production (HANPP: Haberl et al. 2013) to measure the share of human consumption from the primary production of ecosystems; energy return of investment (EROI: Hall et al. 2014) to measure the ratio of energy input and output in agricultural or other production processes; and planetary boundaries (Cornell 2012) to measure the global limits of natural resource use.

These indicators show different aspects of the problems of changing agricultural and other forms of production and land use, applicable also for urban and peri-urban areas. The social processes of innovation and change on the way to resilience and sustainability require improvements of resource use, also more efficient forms of conflict mitigation in natural resource use. We do not discuss these aspects further here, but show in the following illustration empirical examples from European research projects in which we participated. These examples illustrate the problems of transition management with knowledge from local case studies of peri-urban and urban agriculture and gardening.

11.3 Case Studies of Peri-Urban and Urban Agriculture and Gardening

11.3.1 Peri-Urban Agriculture

The RETHINK-project[1] researched the challenges of re-thinking farm modernisation that suffices requirements of reduced vulnerability, increased resilience and sustainable management of natural resources.

From the case studies of the RETHINK-project we summarise two studies, taken from the case study reports, from Switzerland, and Sweden that dealt with peri-urban agriculture.

The Swiss case study (Bourdin et al. 2015) in the agglomeration Bern, had as focus theme milk production in a peri-urban area and different supply chains for milk products: a dominant/conventional supply chain and new paths for milk valorisation on regional markets that include different forms, also the supply chain of organic producers. Supply chain development and management are important complementary components of peri-urban agriculture that cannot be understood from the specific conditions of production forms and processes. The logic of the two types of supply chains can be seen as similar to the differences between bio- and eco-economy strategies, the first type representing a more conventional and growth-based bio-economy, the other one an alternative "ecological" sector. An important component of the Swiss organic farming sector is the building of a national supply chain in cooperation with big retailers which makes the sector less vulnerable to minor economic shocks. The adaptability of the conventional and the organic milk producers is similarly good, and both sectors developed also transformation capacities, however, not in a coherent perspective of sustainability, rather in competing forms of "greening of agriculture". The specificities of peri-urban agriculture in the Swiss case study show that milk production and keeping of cows, sheep and goats are less difficult in peri-urban areas than keeping of pigs and poultry. Horse keeping for urban riders is found in all Swiss peri-urban areas. Altogether the changes described in the two agricultural sectors are complex and so are the processes of adaptation and transformation; this shows the necessity of developing governance structures that connect to specific networks and social learning systems. The case study argues that for the organic sector of production, because of its diversity, it is difficult to coordinate the different interests of the farmers, for example, regarding farm development. Furthermore, a contrast in interests and expectations of urban consumers and farmers is found, with the urban population often conserving a "romantic image" of farming that is not realistic with regard to the changes through farm enlargement and modernisation.

[1]RETHINK—Farm Modernisation and Rural Resilience, was a transdisciplinary research project supported by the European Commission and funding bodies in 14 countries under the umbrella of FP7 and the RURAGRI ERA-NET. For more information on the project consult the webpage http://www.rethink-net.eu/home.html

Summing up, in the Swiss case study heterogeneous trends and development processes have been identified that influence the further development of peri-urban agriculture in the perspectives of resilience and sustainability. In spite of the high adaptability agriculture in the area (as in Switzerland generally in the past decades) it is assumed that the future is not a continuity of the past agricultural development: new decreases of milk prices could, for example, have as consequence that a large part of middle size milk producers terminate their production. This will lead to the need to find other economic activities that may ensure the permanence of farms or their replacement by new forms of land use. Also, for the farms close to the city of Bern similar trends can be observed as in the Swedish case study: famers are threatened to lose farmland with the spreading of the city and new settlement and building.

In the Swedish case study (Olsson et al. 2015) agriculture in the periphery of an urban agglomeration is studied. The forms of peri-urban land use differ showing a strong influence of urban interests. The transformation of agricultural land use in the periphery of Gothenburg city confirms a growing influence of urban populations and their interests in land use on farming. In an exemplary way this can be seen in the changing forms of land use: agriculture goes away from food production, not mainly towards the new forms of bioenergy production on agricultural land, but towards extensive horse keeping. This has become an important form of land use showing the interest of urban population in riding. Horse farms are widespread in the study area, but the whole transformation of agriculture in the periphery of the city is more complex, as revealed in a longitudinal study of agricultural land use.

Today farms that use the proximity to the city for food production for the local urban market coexist with other ones that provide services for the urban population, and different forms of landscape management by farmers, also in protected areas. Four overlapping adaptive strategies of land use have been identified: (1) agricultural land use that can be changed quickly (e.g., horse farms); (2) conventional diversification and pluri-acitivity of farmers; (3) multi-functional agriculture (especially combination of food production and landscape management); (4) cereal production for different consumers.

All of these development strategies are characteristic for peri-urban agriculture under the influence of urbanization and urban interests, whereas the prior forms of small-scale and mixed agriculture for local markets have vanished. They represented the last form of a conventional agriculture that developed within the national Swedish agricultural modernisation policy after the Second World War, already influenced by urban markets. With the growing influence of urbanisation on farming adaptability and transformability as requirements of social-ecological resilience became more important for farmers. The development of farms appears as less stable in the long run; farmers need to adapt and transform their agriculture continuously and more actively, trying to find new forms to be able to continue farming.

The development of peri-urban agriculture showed two phases: first the transformation of small family farms to diverse new forms of farming, and in the second phase additional forms of differentiation of agriculture under the influence of urbanisation-driven change, with two dominant forms: food production for the local urban market and horse keeping.

The long-term trends of land use change identified in the case study include: agricultural land is transformed into urban land for building (presently minority); arable land transformed to other use, livestock grazing and riding (majority); continuing agricultural food production (minority); abandoning of livestock grazing in the outlands that transform into new forest areas. This last form is specific for the metropolitan area of Gothenburg, a trend that differs strongly from other metropolitan areas in Europe: large areas in the urban periphery were no longer used for agriculture, but reforested.

Complementary to the phenomena of agricultural transformation the following development forms influencing peri-urban agriculture are important: large parts of peri-urban agricultural land belong administratively to the city; it is a coastal area with competitive use of land for the urban (industrial) and third sector economy (transport and communication, e.g. harbours, local and supra-local tourism, seasonal dwelling and commuting of urban residents, land use for sports and recreation). Collaboration among farmers developed in this area since long time in specific forms of agricultural modernisation (cooperatives, the early phase) and the general forms of local, community-based cooperation that included also agriculture (local movements, with active support through governmental institutions). The local movement- and network-based, often informal, cooperation is still influential in the late-modern peri-urban development of agriculture, whereas direct cooperation of farmers (e.g. through machine rings) has become less important.

In the Swedish case study resilience and sustainability in the urban fringe are developing through a culture of social learning that supports the adaptation and transformation of peri-urban agriculture and shows the blending of rural and urban traditions of communication: community-based local movements, urbanisation of the countryside, and the inclusion of land use planning into urban planning that includes agricultural land and protected areas in the urban periphery.

Further case-studies in other European countries participating in the RETHINK-project dealt with agricultural transition to resilience and sustainability in various forms of rural areas. From all the case studies (accessible through the project website RETHINK) the requirements of adaptability and transformability of agricultural land use can be described as follows:

1. *Matching the contrasting requirements of permanence and change* is a general requirement of resilience and sustainability for all forms of agriculture studied, in a process perspective where relative stability/persistence is achieved through adaptation of farms to changing conditions (continuous process), and at certain times through transformation (transition to other production systems, far reaching system changes, rupture of development paths).
2. *Matching autonomy* (as enabling change) and *network embeddedness* (enabling efficiency and providing information) of farms is a precondition for resilience and sustainability transformation where farmers become participants in larger development-directing forms and networks of cooperation.
3. *Unfolding cooperation* that is supported through local networks and movements is often seen as contrasting with the power- based hierarchies created by

governmental organisations. But integration of top-down and bottom-up perspectives in sustainability governance becomes a main requirement of future development.

4. *Informal social networks* are supporting the resilience- and sustainability-oriented innovations, adaptation and transformation of farming, in the case studies mainly illustrated through organic farming and other forms of environment-friendly agricultural production.
5. *Social learning:* favourable conditions and contexts for social learning that support the development of social-ecological resilience include a variety of factors that create resilience—cooperation between farmers and across sectors, social networks that include other actors than farmers, development and change of farms that allow for adaptation disturbances, shocks and changing conditions of markets and environmental conditions in the longer perspective of sustainability transformation.
6. *Diversity of production forms* and activities at the farms in the study areas (in difference to diversification of the production and other income-generating activities on the single farm) is a context component that may support resilience and sustainability regarding social and ecological diversity at landscape or regional levels. However, it includes also contrasting factors that do not support resilience, being often mainly market-oriented adaptation in the short run.
7. *Resistance to change* can be found in strategies ignoring resilience and sustainability in attempts to continue agricultural development on specialisation and growth based development paths. Such resistance to change is often connected with the orientation of farmers to the conventional logic of modernisation, to food production and to growth that contrasts with transformation processes towards forms of agriculture compatible with the criteria of an eco-economy or sustainability.
8. *Threats and tensions* emerging in the processes of adaptation and transformation of agriculture include for farms the insecurity about the long-term future of agriculture, the need of high investments, the high workloads to deal with the bureaucratic requirements of regulation and policy, the high prices of land, and the competing land use demands from other economic sectors and urbanization. From other sectors of the regional economy and from local inhabitants agriculture does not always get sufficient support.

The adaptation and transformation processes, confronted with these contrasting requirements, do not just require technical and social innovations. Innovations can only become effective when they are combined with other capacities, for example in peri-urban agriculture with that of flexibility in land use as it is described in exemplary forms as multifunctional agriculture (Renting et al. 2009).

Experiences in European countries with policies and strategies of adaptation and transition to sustainability in connected rural and urban areas show the growing importance and the differentiating forms of urban agriculture and gardening. In the following section we describe an example of an innovative project of urban gardening that shows as well the difficulties as the possibilities of transition to sustainability.

11.3.2 Project "Urban Gardening": Case Study Lisbon

In the Portuguese case study in Lisbon urban gardening is at the same time contributing to reinforce biodiversity, to increase the resilience of the city to floods, and contributing to increase family income of immigrant communities and families hit during the recent economic crisis[2]. Allotments started to grow spontaneously since the early 1960's mainly in the peri-urban areas, related first with the migration from rural areas to the city, and, in the 1980's associated with migrant communities, especially those coming from former Portuguese colonies (Cabannes and Raposo 2013; Matos and Batista 2013; Cabral 2014). More recently the economic crisis and high unemployment rates have transformed this small farming production into a fundamental mean of subsistence for many families. The newcomers in the city started using and occupying urban voids, both municipal and private.

Therefore, the Lisbon municipality decided to intervene, planning and integrating the spontaneous "movement activities" into the development of green infrastructure of the city. This process of reorganisation of non-regulated allotments is part of the Lisbon's Green Plan, adopted in 2007, were agriculture was assumed as an important component of the ecological structure of the city; urban agriculture provides not only food but several ecosystem services that are essential to establish a green infrastructure and to connect urban, peri-urban and rural areas functionally (CML 2016). Within this framework a Strategy for Urban Agriculture was defined and the Municipality started a process of regulation of these areas creating Horticulture Parks. They consist of urban infrastructures used by farmers, but they are also open to the public, for different leisure-time uses and creating pathways for pedestrians and bicycles, approaching the agricultural activities of the remaining population. These horticultural parks aimed at addressing several challenges: (a) to enlarge the scarce green spaces in the city; (b) to link most green spaces through ecological corridors; (c) to mitigate the impact of channelling waterlines by creating water basins in strategic valleys and to provide ecological services; (d) to reorganise allotments that were growing fast (partly due to economic crisis and rising unemployment) and unorganised; (e) to meet the increasing demand for allotments driven by middle income family's desire to establish a healthy life style, to connect to nature and to ensure the quality of food products they eat, and, (f) to contribute to food production providing quality food (organic production is mandatory or highly incentivised) (Matos and Batista 2013; Bernardo 2013). A total of 20 horticulture parks (municipal allotments) were projected to be created until 2017; in 2014 ten horticultural parks were already open for the public (CML 2016).

[2]See, furthermore, in this book, the chapter from Fassi and Sedini, discussing an interesting case COLTIVANDO —The convivial garden at the Politecnico di Milano. The recently published book by Calori and Magarini (2015) gives examples on sustainable food policies from more cities; our text describes the processes of transformation to sustainability in broader terms, as more complex social processes from which the food policies are only a part.

This process implied reorganising and unifying the plots, providing infrastructures, water access, and small sheds for tools storage. Two types of allotments were created varying in size and function:

1. the plot located in a social allotment park has around 150 square meters, is meant for subsistence and the surpluses can be sold;
2. a recreational or pedagogic allotment park holds in average plots of 100 square meters, organic production is mandatory and is only for own consumption.

The policy intends to respond to the increasing number of families who wanted to "return to earth" and produce their own organic food. In both cases an annual fee is due as a contribution to maintenance, technical training on organic production and water use, but low income families get discounts that can reach 80%. Due to the increasing demand for allotments, the city has not only organized the former allotments but also created new ones.

Among those horticultural parks Chelas Valey is the largest, covering about 15 hectares, of which 6.5 are used for urban gardens, including 400 plots, each with 150 square meters, with a share allocated directly to about 100 people who had already unofficially created allotments (Cabannes and Raposo 2013), with the remaining reserved for a public tender carried out in 2013. Today in those plots coexist "old farmers" in activity for several decades and others who only started after the recent reorganization of the allotments. The relationship among them is reported to be very good, conflicts are rare. Collaboration is a norm; they exchange agricultural practices, seeds and products. The type of crops grown is diversified according to the nationality of the farmers from Portugal, India, Cape Verde and Angola (Luz and Pires 2014).

The process of developing these horticultural parks was top-down, totally designed by the Municipality. The previous users were not consulted or involved in the process, they have just been notified that they should leave the place during rehabilitation works and could return later. But they had to comply with the rules defined by Municipality, namely: the organic mode of production (after technical training offered by the municipality), composting, no use of chemical pesticides or herbicides, of chemical fertilizers, of Genetic Modified Organisms (GMO), of infesting species, and no construction of unauthorizsd types of fences or shelter structures, or planting of trees.

Nevertheless, and although still ongoing, the reorganisation process of informal allotments seems to have turned into a positive and cooperative strategy for urban transformation. Changes that came with the municipal intervention were perceived as stimulating by the older farmers that emphasised access to water and other infrastructures as an improvement justifying the introduction of annual fees. At the same time the development attracted new users for leisure activities or new urban farmers (Luz and Pires 2014).

In Lisbon urban gardening is contributing to increase resilience in the double sense of (a) resilience of the city by improving its capacity of producing food and providing ecological services, as well as (b) resilience of families and individuals towards economic crises. At the same time urban gardening also provides a

momentum for increasing social cohesion and integration of immigrants. In the social allotments the users report positive impacts in socialisation (of those who are retired), food security of the family (in the case of unemployed), and even creating opportunities for small scale entrepreneurship as they are allowed to sell surpluses. It seems that this project under the guidance of the municipality has created an innovative social infrastructure for transformation to sustainability on which further and more large-scale projects of sustainability governance can build (Luz and Pires 2014).

11.4 Discussion: Integrated Local Strategies for Innovation and Socio-ecological Transformation

Local strategies for innovation and socio-ecological transformation need to work with contradicting and contrasting requirements as a continuous challenge. This can also be described as requirement of inclusive and multi scale politics or governance processes, as in the commentary article on "transforming innovation for sustainability" by Leach et al. (2012). These authors formulate the framing conditions and perspectives that allow further discussion of the examples of peri-urban and urban agricultural projects described above. The authors summarise their reflections as follows:

> "The urgency of charting pathways to sustainability that keep human societies within a 'safe operating space' has now been clarified. Crises in climate, food, biodiversity, and energy are already playing out across local and global scales and are set to increase as we approach critical thresholds. . . . ambitious Sustainable Development Goals are now required along with major transformation, not only in policies and technologies, but in modes of innovation themselves, to meet them. . . . such 'transformative innovation' needs to give far greater recognition and power to grassroots innovation actors and processes, involving them within an inclusive, multi-scale innovation politics. The three dimensions of direction, diversity, and distribution along with new forms of 'sustainability brokering' can help guide the kinds of analysis and decision making now needed to safeguard our planet for current and future generations." (Leach et al. 2012:1).

What the authors describe as "radically new approach to innovation" includes the following components:

1. Re-directing of change in accordance with criteria of sustainability,
2. Supporting diversity and experimenting with different approaches of policy innovation,
3. Distribution in the sense of sharing the burdens and the advantages from transformation.

These are three procedural requirements that can also be applied in the examples we described. The challenge described by the authors as connecting local and grassroots innovation capacity with the requirements of global change and planetary boundaries of resource use (Leach et al. 2012: 5) can be seen as necessity of all strategies of sustainability governance.

Important common elements in the varying conditions for local, urban-rural projects for resilience and sustainability can be seen in the capacities to learn and to cooperate that are required from the heterogeneous actors participating the processes of local development and transformation. These processes of social learning and cooperation of actors reflect the complexity and elasticity of resilience and sustainability that are seen as examples of "essentially contested concepts" (Collier et al. 2006, see above: conceptual challenges of transition strategies). Both of the concepts are defined and interpreted in many different ways, no consensus about their interpretation is achieved; but still they can be applied in meaningful ways, as we tried to show. Furthermore, the concepts are necessary to deal with the global environmental problems. It can be argued, that resilience and sustainability became overused and over-interpreted, give no longer a safe compass and guidance for sustainable transformations. But this seems more to show the nature of the problems to deal with than the bad quality of the concepts. The future sustainable society is unknown and has to be built with knowledge developed and experience gained in the transformation processes. Transformation needs to be constructed anew and continually adapted in the long process, with measurable concepts. In this transformation process the ideas of resilience and sustainability require re-interpretation and modification with the growth of scientific knowledge and the changing conditions and consequences of global change that affect local development in unforeseeable ways. For cities the unforeseeable future can be seen as a paradox that includes the urban sustainability multiplier described by Rees: cities do not have ecological disadvantages only, also a series of advantages that help to save material, energy, space and using resources effectively, thus chances for more sustainable resource use. These contrasting qualities of cities stimulate social and technical innovations in search of a future sustainability; furthermore, the contrasts make such strategies of sustainability governance as the development of new forms of urban and peri-urban agriculture a necessity of further rural-urban development. The contrasts of rural and urban areas, of rural and urban development, of hinterland and global cities, have now reached the cities themselves that reconnect rurality and urbanity in the urban landscapes.

11.5 Conclusions: Requirements of Further Development of Integrated Transformation Strategies

Integrated urban-rural sustainable development requires new governance models for effective adaptation and transformation; and it requires learning from the weaknesses of former approaches. Metropolitan areas experience worldwide similar difficulties, paradoxes and challenges in their efforts of transition management and local sustainable development after the Rio-conference in 1992. The transformation processes are more complicated than expected; they require long-term perspectives, new visions and social innovations, better integration of rural and urban development,

greater efforts and more human, social and knowledge resources than imagined. The real challenges are only gradually perceived, when global change affects local development. From the examples we described and discussed, we can derive the main requirements of integrated strategies of resilience and sustainability as follows:

- Achieving sustainability implies more complex and systematic forms of inter- and transdisciplinary knowledge integration; these include integration of scientific knowledge from the social and natural sciences and practical, for example local ecological knowledge, from social actors and practitioners.
- Furthermore, specific forms of collective and social learning by the actors involved, e.g., "double loop" learning are required. This implies not only learning to develop joint action strategies, but the learning to anticipate and take into account in present action its future consequences. The challenges of such social learning include that of dealing with complexity, uncertainty, conflicts and power asymmetries.
- Strategies to enhance the transformative capacity of the SES include different components—strengthening collective action and cooperation of resource users; developing mechanisms of multi-scale and multi-actor governance to deal with contrasting requirements; building transformative capacity of individuals, groups and institutions; developing process models of navigating transformations through different stages of development, with periods of turbulence and uncertainty (Olsson et al. 2006).
- Transformation networks are networks of social actors and institutions that are able to initiate and maintain processes of socio-ecological transformation. They are a core component of governance for sustainability transformations, at different levels and scales of action. The capacity of such networks implies more than political action and coordination: complex forms of collective action in which social, cultural, political, economic and ecological changes are integrated in the broader processes of socio-ecological transformation.

In all processes of sustainability transformation time is a key aspect, and an "unknown variable": the future is open and unknown; it is not determined by our present action, but influenced in ways we cannot foresee. Transformations to sustainability require long-term perspectives—of several generations or centuries—and for such a long process no forms of action can be kept during the whole process. This underlines the necessities of experimenting and the capacities of social learning and cooperation, to realise the changes of strategies that are necessary in the transformation process.

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