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The resilience of social and ecological systems: taking account of uncertainty for development

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The development and humanitarian community has established its own school of thought on resilience in order to link its emergency actions with its medium- and long-term development strategies. Intervention contexts are becoming increasingly uncertain and complex, raising new challenges that need to be addressed. The school of thought on social and ecological system resilience can provide complementary approaches to help understand the intervention context and the

multiple dimensions of challenges, as well as to develop and assess adaptation pathways. These approaches enable accounting of ecological dynamics and interactions among social groups, provide a diversity of knowledge and potential development pathways and, ultimately, support societal transformation. Collaboration between these two schools of thought would provide valuable opportunities.

Two different but complementary schools of thought on resilience

Change is now the norm, and the term *resilience* has become common currency. It is used by development and humanitarian actors to establish a framework for sustainable development implementation in regions affected by recurrent crises: the goal is to identify synergies between emergency interventions (in direct reaction to a disaster) and medium- and long-term development strategies.

A number of non-governmental organisations, aid agencies, international organisations and research centres have consequently developed a community of practice and a conception of resilience, which will be known here as *development resilience*. This school of thought differs from the earlier one of *social and ecological system resilience*, which the Resilience Alliance scientific network defines as the capacity of a social and ecological system to absorb or withstand a perturbation or stressor, while maintaining its structure and functions thanks to self-organisation, learning and adaptation processes. These two schools of thought overlap for numerous points, but have developed different reference frameworks and tools.

Both schools of thought focus on the dynamic pathways of collectives, though the collectives in question differ. In development resilience, the collective is the most vulnerable social group at the time of the analysis. In social and ecological system resilience, the collective is the entity known as the *social and ecological system*, which encompasses a human society and its

environment. Both schools of thought recognise the existence of tipping points and highlight the key role of certain properties, such as social capital, or of certain processes, such as learning, in enabling these collectives to adapt to change.

The tools and approaches of the development resilience school of thought seek mainly to improve living standards and food security for the most vulnerable individuals or households. These objectives are, for example, the strategic pillars of the Global Alliance for Resilience Initiative (AGIR), co-ordinated by the European Union and 17 West African and Sahelian countries. In order to assess the effectiveness of actions undertaken, other tools have been developed to quantitatively and qualitatively measure resilience.

The social and ecological system resilience school of thought, on the other hand, recognises the possibility of multiple viable pathways in the long term. Its approaches and tools take into account social and ecological feedbacks and the existence of many types of knowledge. A historical example, studied by the geographer Georgina H. Endfield, illustrates how this school of thought explains the resilience of a social and ecological system in Mexico faced with climate perturbations and social and political changes between the late 17th century and the 19th century. Prior to this period, communities combined several adaptation strategies in order to survive food shortages caused by frost, floods and droughts: polyculture, irrigation and collective water management systems, storage and seed exchange processes, and food reserves. Colonisation brought about changes in demographic trends, social organisation and land use. The

successive climate crises during this period stimulated collective innovation and learning, with the new responses corresponding to the different levels of social organisation – individual, community, regional and national. Food storage and exchange systems were introduced at the national level, for example. Similarly, people acquired and shared knowledge about river flow regimes, leading to the construction of dams and the adoption of community rules on the maintenance of river banks in order to limit flooding.

The heightened pace and hyperconnectivity of today's world complicate development issues, thereby increasing uncertainty about (1) how the intervention contexts will evolve, and (2) the potential impact of any action. The social and ecological system resilience school of thought can provide complementary responses to those of the development resilience school and yield new opportunities for incorporating this continuous, uncertain change into development approaches. The goal of the international conference *Resilience 2014, Resilience and Development, Mobilizing for Transformation* (4–8 May 2014, Montpellier, France) was specifically to open a dialogue between these two schools of thought. The conference confirmed their differences and identified new avenues for action.

The four lines of action for development proposed by the social and ecological system resilience school of thought

The school of thought on social and ecological system resilience proposes four lines of action for projects and policies aimed at coping with change:

- > integrating ecological dynamics and all social groups;
- > recognising the plurality of knowledge and viewpoints held by the different stakeholders;
- > maintaining several potential development pathways and assessing their ongoing relevance;
- > supporting societal transformation and rethinking the role of institutions.

Integrating ecological dynamics and all social groups • Much of the research by this school of thought mobilises ecosystem services and their quantification, with a dual objective: first, integrating ecological challenges into resource management processes and, second, including environmental feedbacks, which are often underestimated and may interfere with the expected impacts. **Box 1** shows how a forest policy in Niger did not fully achieve its objectives because it failed to take into account the interactions between the many uses of forests, even though these practices concern the same communities and the same plants.

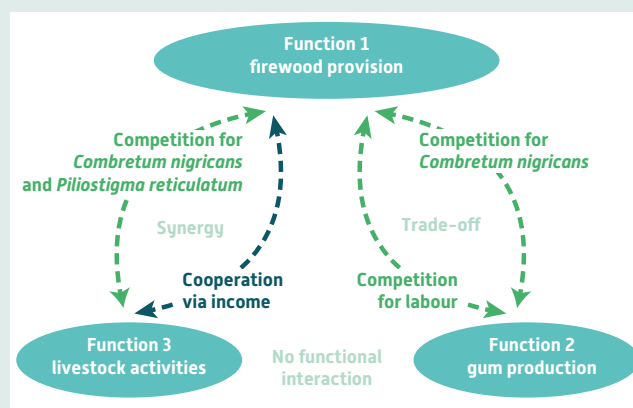
Recognising a plurality of knowledge • The social and ecological system resilience school of thought advocates “adaptive co-management”, in other words an iterative decision-making process involving actors – including scientists – with different powers and mandates, and proposing continuous observation of the system and regular re-evaluation of decisions made. This process ensures the key stakeholders’ viewpoints are taken into account, by considering different pathways and adjusting these to future context changes (**box 2**).

While a particular state could be desirable for some, this might not be the case for others. Within the same society, the optimal pathway for increasing the resilience of one group of individuals may result in an undesirable state for other groups. Explicitly taking account of the diversity of knowledge and viewpoints held by stakeholders acting on several levels, as well as their inherent gaps and contradictions, helps to identify the different challenges. The VoiPastorales project conducted in Senegal (see **box p. 4**) addressed this issue by organising participatory theatre workshops to discuss the synergies and conflicts between climate change adaptation strategies in pastoral societies. During these workshops, national and local actors discussed their different viewpoints, thus revealing mutual misunderstandings. This preliminary stage outlined the challenges linked to the development models advocated by the different actors. Further dialogue is now needed on these challenges in order to define actual policies for local populations.

Box 1. What social and ecological functions tell us about forest management policy implementation in Niger

Social and ecological functions are the processes emerging from interactions between ecological and social systems. This concept has been useful in exploring the impact of a forest policy reform in the Sahel in the early 1990s.

In Niger, rural firewood markets were set up in order to regulate firewood harvesting and trade. A study of the social and ecological system focused on one of the first markets identified 16 social and ecological functions, including gum production, livestock activities and firewood provision. The interactions between these functions had a greater influence on the system pathway than firewood harvesting and trade. These findings call for greater consideration of interactions between social and ecological functions in policies aimed at improving resilience.



Functions 1 and 2 are competing, since they concern the same shrub (*Combretum nigricans*) and are carried out by the same people: this results in a trade-off between the two functions.

Functions 1 and 3 also concern the same shrubs for wood and fodder (*Combretum nigricans* and *Piliostigma reticulatum*), but cooperation is stronger than competition, since the income provided by each function facilitates the other. The resulting interaction is therefore a synergy between these two functions.

Box 2. Support for natural resource management changes in Thailand through adaptive co-management

For several years, researchers accompanied people living in a catchment area in northern Thailand in the transitions required to cope with numerous changes, based on an adaptive co-management approach. Some changes were made necessary by the context and others resulted from agricultural practices. The general discourse on the effects of erosion caused by farmers in this region was problematic for locals, who were asked to adapt their activities. Our approach revealed the slow processes underlying the system dynamics, thereby enabling discussions on potential tools for action.

An initial phase of knowledge sharing between scientists and farmers showed how most people had transformed their practices in just a few years by planting fruit trees and tea to increase their income. The social and ecological system thus shifted to a different operating mode that limited erosion (ecological component) and stabilised income (socio-economic component). But some people, especially smallholder farmers, were unable to make changes to their production system due to a lack of investment capacity. For these actors, the system was resilient in a negative sense: they were caught in a poverty trap. In order to increase this capacity for change, a second participatory process was launched, exploring types of credit that could enable all farmers to change regime. This shift towards new agricultural practices nevertheless raised another problem: plantations of fruit trees and tea require other types of irrigation. A third phase was therefore organised and revealed a final obstacle: the intervention of an actor in charge of regional planning and water management at the regional level. A disagreement between villagers and this actor prevented the broader development of irrigated agriculture. In terms of resilience, this new threshold was therefore not crossed.

Maintaining several potential development pathways and assessing their ongoing relevance (see figure opposite) • A pathway considered to be viable at a given moment may later prove unachievable due to unexpected changes. If this pathway was the only one selected, having been initially deemed optimal, the project or policy would thus be a failure.

Moreover, taking uncertainty into account calls for a different approach to measuring resilience. It is important that the nature and form of monitoring indicators can evolve according to new constraints and context changes. The social and ecological system resilience school of thought proposes continuous assessment processes that ensure this adaptability of monitoring indicators.

Supporting societal transformation and rethinking the role of institutions • Approaching a social and ecological system through the prism of resilience also implies recognising that resilience may be a problem and that the system may therefore need to change. Some groups are stuck in very resilient yet unacceptable situations: this is the case of poverty traps in some parts of the Sahel. Only a radical transformation through structural changes in social and ecological systems concerned will break this vicious circle. The example in box 2 shows how types of governance and power relations between actors must be taken into account in order to achieve such changes.

The impact of the changing context on potential social and ecological system pathways

The dotted lines in **figures 1** and **2** show the potential development pathways of the social and ecological system, as considered at two points in time: t (**figure 1**) and $t + x$ (**figure 2**). Shown as a beige dotted line in figure 1, pathway 4 crossing social boundaries is unjust, and pathway 5 crossing ecological boundaries is ecologically unviable. Pathways 1, 2 and 3, shown as black dotted lines, are the only feasible ones. However, in the period x , this system evolved along the pathway shown as a solid black line. Environmental changes (such as climate change) and social changes (such as a population movement) altered the ecological and social boundaries. This increased constraint on the system invalidates pathway 1, and only pathways 2 and 3 are still viable.

Figure 1
at point t

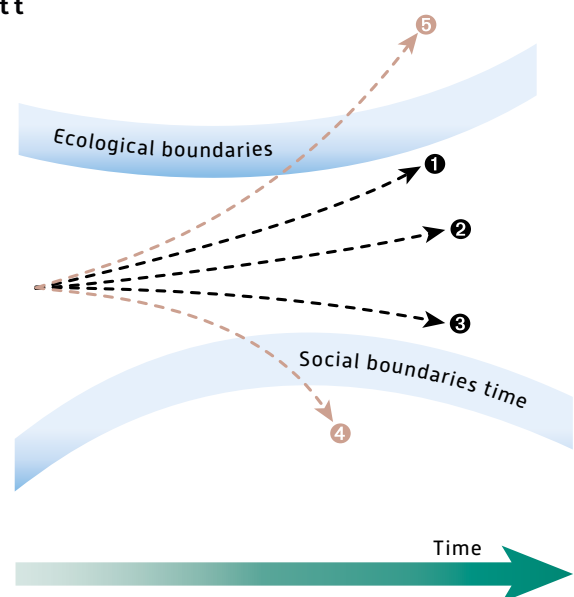


Figure 2
at point $t + x$

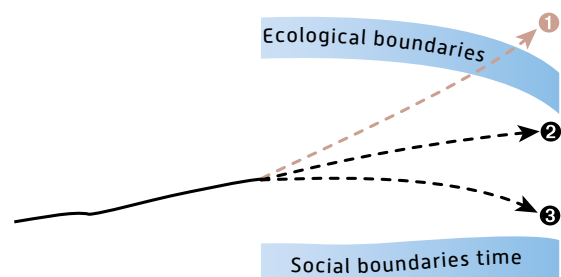


Diagram inspired by the two following sources:

- figure 4 in the open access article by Bousquet F. et al., 2016. <https://doi.org/10.5751/ES-08754-210340>,
- figure 6.2 p. 87 in the open access document: ISSC and UNESCO (2013), World Social Science Report 2013, Changing Global Environments. OECD Publishing and UNESCO Publishing, Paris, 612 p. <https://doi.org/10.1787/9789264203419-en>.

In conclusion, the social and ecological approach to resilience may be complementary to an approach based on improving living standards for the most vulnerable. These approaches currently leave two key questions unanswered:

- Which organisational levels and actors are concerned, and what are the interactions occurring between the processes underway at different levels on the one hand, and between the actors involved on the other? So far, concerns and actions have focused on two levels: either humankind and the planet as a whole, or a local community in relation to its environment. But what roles do the actors that bridge the gap between these levels play, and in particular states, whose own resilience is in question?
- Who defines the resilience of whom, and how? Two opposing models exist. The first entails experts defining resilience, which is achieved by top-down actions, and the impacts of

these actions are measured using quantitative indicators. The second is an iterative process entailing the collective definition of goals and of actions to be undertaken, with ongoing assessment. Hybrid forms combining both models undoubtedly remain to be developed.

Since the international conference *Resilience 2014*, bridges have been built between actors from both the development resilience and the social and ecological system resilience schools of thought. However, collaborations still need to be strengthened in order to truly address these issues. Now is the time to leverage different modes of organisation, a range of stakeholders (development organisation *versus* research centre) and commitments towards complementary collectives – the most vulnerable populations *versus* the whole of society in its environment. ■

Perspective n°43 is based on an analysis of presentations at the international conference *Resilience 2014, Resilience and Development, Mobilizing for Transformation* (www.resilience2014.org), which took place from 4 to 8 May 2014 in Montpellier (France) and was financed by a number of funders, including EuropeAid-Devco (<https://ec.europa.eu/europeaid/>), Bioversity International (www.bioversityinternational.org/) and CIFOR [Center for International Forestry Research, www.cifor.org/].

The authors and their partners have also published the following documents on the subject covered in this *Perspective*:

Barnaud C., Promburom T., Trébuil G., Bousquet F., 2007. An evolving simulation/gaming process to facilitate adaptive watershed management in northern mountainous Thailand. *Simulation and Gaming* 38(3): 398-420. <https://doi.org/10.1177/1046878107300670>.

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Resilience and development: mobilizing for transformation. *Ecology and Society* 21(3): 40. <https://doi.org/10.5751/ES-08754-210340>.

Mathevet R., Bousquet F., 2014. Résilience et environnement : penser les changements socio-écologiques. Paris, Buchet/Chastel, 176 p. ISBN 978-2-283-02736-3.

Rives F., Antona M., Aubert S., 2012. Social-ecological functions and vulnerability framework to analyze forest policy reforms. *Ecology and Society* 17 (4): 21. <https://doi.org/10.5751/ES-05182-170421>.

Vonhron S., Dury S., Fallot A., Alpha A., Bousquet F., 2016. L'intégration des concepts de résilience dans le domaine de la sécurité alimentaire : regards croisés. *Cahiers Agricultures* 25 (6), e64001. <https://doi.org/10.1051/cagri/2016039>.

Finally, the *VoiPastorales* project – *Strengthening the resilience of pastoral systems through the theatre forum* – (a project by CIRAD and its partners in Senegal), which followed on from the conference, is described in a video available on the website <http://ur-green.cirad.fr/projets/voipastorales>.

A few links

Béné C., Headey D., Haddad L., von Grebmer K., 2016. Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. *Food security* 8(1): 123-138. <https://doi.org/10.1007/s12571-015-0526-x>

ComMod, The Companion Modelling approach. www.commod.org/en

Endfield G.H., 2012. The resilience and adaptive capacity of social-environmental systems in colonial Mexico. *PNAS* 109(10): 3676-3681. <https://doi.org/10.1073/pnas.1114831109>

European Commission. Resilience.

http://ec.europa.eu/echo/what/humanitarian-aid/resilience_en

Global Alliance for Resilience (AGIR) Sahel and West Africa. www.oecd.org/site/rpca/agir/

Lallau B., 2011. La résilience, moyen et fin d'un développement durable ? *Éthique et économique/Ethics and Economics* 8(1): 168-185. <http://hdl.handle.net/1866/4589>

Resilience Alliance. www.resalliance.org

A few words about...

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François Bousquet and **Aurélié Botta** coordinated the international conference *Resilience 2014*, and are members of the Resilience Alliance and the ComMod networks.

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