Transition Pathways for Sustainable European Regional Development

Daniel Magwegwe[1], Rik Eweg[1]
[1]Van Hall Larenstein University of Applied Sciences, Velp, The Netherlands

Abstract

This paper describes prototypes for transition pathways towards inclusive, sustainable development for seven regions in five European Countries. The approach for developing transition pathways was based on three theoretical building blocks. First, the ABCD-Roadmap that outlines the various steps to be developed in the design process of the transition pathway, secondly, the Socio-Ecological-System framework was used to describe the current situation and analyze the interactions within the system and lastly, the X-curve model provided guidance in categorizing activities and policies that should be adapted, developed new or stopped. The international team showed how transition pathways for sustainable development can be developed in different contexts and scale levels, all over Europe. The resulting advice can be helpful to professionals active in regional development, on municipal, provincial, national, or European level.

Key words: Transition pathways, regional transition, transdisciplinary, multi-stakeholder, regional development.

1. Introduction and background

Sustainable European regional development is an issue that needs to be addressed holistically at every level of society (Sen A, 2013). Considering the complexity of challenges that regions have been facing over the last decennia, new approaches that lead to sustainable systemic changes must be developed. In most recent years, challenges that Europe faces include climate change and environmental sustainability, social cohesion and demographic shift, political and geopolitical issues and biodiversity losses. An example is that as climate change continues to intensify, climate-related resources (e.g. water) will be scarcely available which can trigger conflicts. When communities have competing claims to a limited resource, social cohesion can be reduced. These challenges need a holistic approach because there is a high level of interconnectedness amongst these different challenges. These challenges are wicked problems that cannot be addressed in isolation and require sustainable systemic changes.

According to various research and literature sources, the urgent and systematic call for action to resolve complex challenges in Europe, aligns with idea that we "*we cannot solve problems with the same thinking we used when we created them.*'' This implies that conventional approaches do not attain sustainability-oriented and holistic engagement and problem solving. To resolve current wicked problems, there is a greater need to focus on engaging with systems change and more defined futures (Wigboldus et al., 2021). The authors even go further to say, "*we no longer need to think about development processes, but rather about moving towards (transition to/transform into) a situation characterized as being more sustainable.*" This is supported by a line of thinking that views transition processes having an aspired future reference point to work towards. Achieving systems change can range from merely optimizing structures and processes (progressive transitions) to complete system transformation (disruptive and radical transitions) (Hölscher et al., 2018; Stirling, 2015).

In transition theory, a transition pathway is defined as a framework that is used to understand how systematic changes occur and it clearly demarcates the trajectory that leads from situation A to situation B. Transition pathways are open ended, non-linear, and fundamentally uncertain (European Environmental Agency, 2019). As the common saying goes, there are many ways to make an egg, similarly to transition pathways there are many ways and perspectives to a desired future. This implies that transition pathways should not be seen as rigid frameworks designed for the development of sustainable European regions, but rather as wicked and cyclic design processes that may be applied in the context of different regions, scenarios, or cases. They should be flexible, as certain steps may need to be adapted or repeated when conditions or needs change.

To achieve the desired future scenario, transition pathways will be unique for each context and should be based on a broad societal support. Therefore, a shared future narrative, and a feasible and actionable vision is needed. A multi-stakeholder approach is the only way in which such transition pathways can be developed and implemented. Multi-stakeholder participation is driven by the recognition that transformation in complex systems cannot be achieved through simple or technical fixes but rather require new forms of governance that bring stakeholders together to plan and act in new ways (Thorpe et al., 2021). By doing so, every stakeholder involved can contribute their own goals, priorities as well as perceptions. For this process to be fully representative it is essential that all members of society, public authorities, industry, academia, and citizens are involved.

For systemic changes to take place, an interaction between the natural dimension and the social dimension is necessary. The UNDP (2020) identified four dimension that are essential for achieving systemic transformation, which are, collaborating across different levels and actors, integrating efforts within and across sectors, bringing together diverse stakeholders and integrating and diversifying flows of resources and incentives. This is closely linked to the concept of socio-ecological systems (Ostrom, 2009). Socio-ecological systems refer to interconnected systems where human activities and geo-bio-physical resources are inherently intertwined. Both social and ecological components mutually influence the interactions that occur within these systems. These social ecological systems highlight complex and intricate connections between human societies and ecosystems which are essential in approaches for engaging multiple stakeholders to promote regional development. Ostrom describes such systems as ‘the commons’ (Ostrom, 1990). Sustainable regional development concerns the governance of resources in a region by various actors, in which the region must be considered as an integrated system with a natural and socio-economic dimension.

Transitions are complex processes that will constantly need readjustment of the narrative and align with the new realities. Transitions take time, typically in the order of decades (Elzen & Hoffman, 2007). One even could go further to say that transition should not be viewed as fairy tales that will end with “and they lived happily ever after” (Wigboldus et al., 2021). For an impactful transition, transitions need to take a multi-level perspective, in which the relationship between niche innovations, the socio-technical regime and the socio-technical landscape are considered (Geels, 2002). Furthermore, for necessary actions to take place, steps for a transition pathway need to be guided by a common course of action. In our study the steps were based on the ABDCD roadmap (fig. 1) developed by The Natural Step.

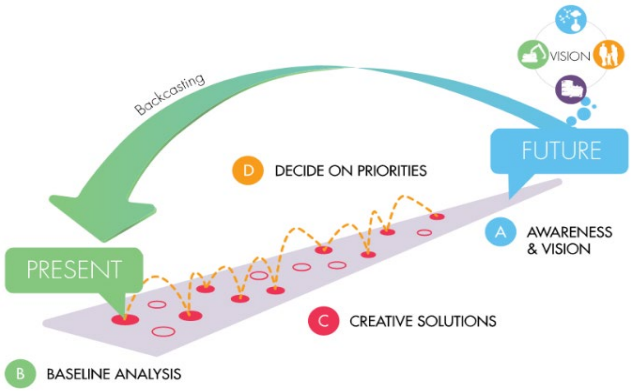

Fig. 1. ABCD–Roadmap developed by The Natural Step: This is a framework developed for achieving strategic sustainable development. The roadmap consists of 4 main steps involve (A) creating a mutual understanding between and then developing a vision (B) conducting a baseline mapping and gap analysis (c) developing future-proof possible solutions to gaps identified and (D) prioritizing actions that can be implemented (https://www.thenaturalstep.de/solution/abcd-process/) .

This paper is based on case studies in which transition pathways have been developed for various European regions, within the INVEST4EXCELLENCE IN REGIONAL SUSTAINABILITY project. INVEST4EXCELLENCE IN REGIONAL SUSTAINABILITY is a European Union funded H2020 project, with the aim of developing sustainable societies and economies in regions across Europe. In this project partnerships of citizens, NGOs, governmental organizations private companies and educational institutions collaborate interdisciplinary in INVEST regional Living Labs. In the project, prototypes for seven transition pathways for sustainable regional development were developed in five countries: Greece, Finland, Slovakia, Bulgaria, and the Netherlands. Each pathway was developed to match with the developmental needs of the specific regions.

2. Methodology

Working in living labs formed the basis of the transition pathways. There is no single definition of living labs. They should be seen as active real-life environments and refer to open innovation or co-creation processes with quadruple helix participation (Witteveen et al., 2023). For this research we adopt the definition that Living Labs are 'physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies, services, products and systems in real-life contexts.' (Westerlund & Leminen, 2011). In the project, seven transition pathways for sustainable regional development were developed in the Invest Living Labs in regions in the participating countries. Each pathway was developed to match with the developmental needs of the specific regions. The transition pathways for the regions were developed for medium term. In our case that was a pathway until year 2035, because the 'medium term' of ten years fits with the time frame of farmers/local

stakeholders.

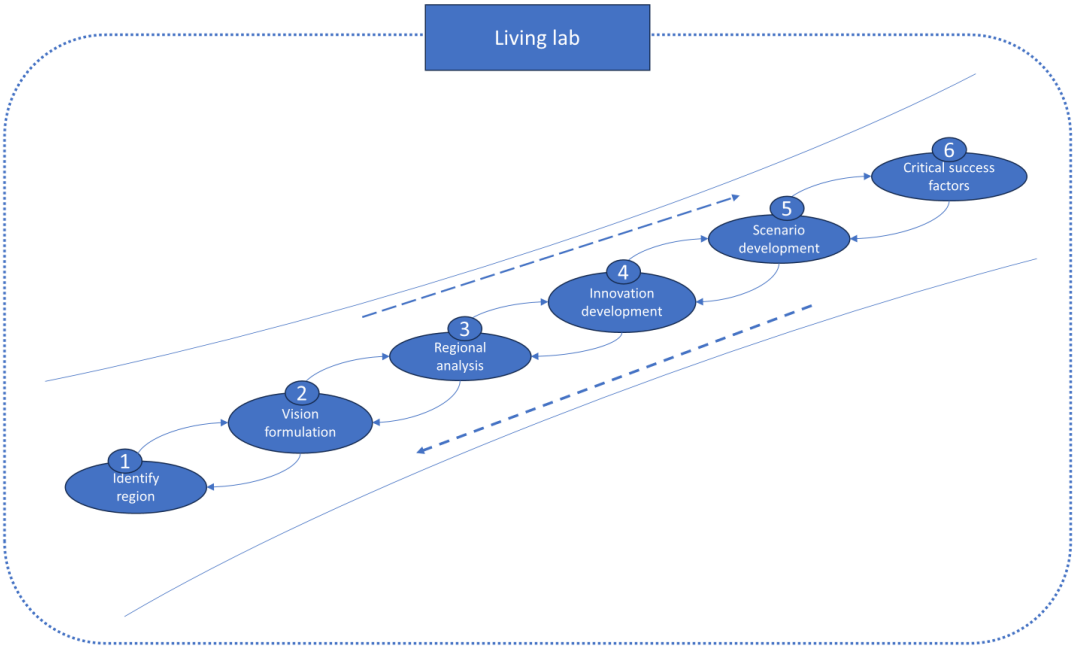

Fig. 2. Research design of the steps in the transition pathway.

The process of developing a transition pathway takes place within living labs and in the case of this research paper within the seven regional living labs. Once the living lab has been defined, the development of the transition pathway would follow a six-step process illustrated in fig. 2. The six steps of a transition pathway are:

Step 1: Identification of the appropriate region where the transition is taking place.
Step 2: Description of the sustainable development vision/ambitions of the region.
Step 3: Systematically analyze and describe the current situation of the region.
Step 4: Development of innovations needed to realize the vision developed.
Step 5: Development of scenarios with timelines for innovative actions to reach the vision.
Step 6: Development of critical success factors and key performance indicators.

These six steps follow a non-linear process but rather an iterative learning and development process. Each step will be briefly elaborated in the following sub-sections.

2.1. Identification of Appropriate region

Identification of the appropriate region starts with the process of defining the physical boundaries of the region. In the process of defining the physical boundary it is essential to make use of geographical boundaries that every stakeholder in the living lab is fully aware of. For the process of defining the appropriate boundaries, scale plays an important role. Thus, the region can be defined from a local village level up to a provincial level, or even national level. However, the bigger the region becomes the more complex the dynamics in the region. The identification of the specific region for the transition pathway should also be matched with the thematic focus of the living lab. There should be a clear alignment between the physical boundaries and thematic boundaries.

2.2. Description of the sustainable development vision of the region

The vision/ ambition of the region describes the direction in which the region aims to develop. The vision is a normative narrative, acting as the 'compass direction' for the future. It pays attention to the main challenges, envisions the future perspective for the region and acts as the main focal theme of the pathway. It is necessary to identify the drivers (social, technological, economic, environmental and policy governance) as well as underlying causes that affect the focal question. To develop the vision, different directions may be explored. The future perspective can be considered as a plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships (Rounsevell & Metzger, 2010). The development of the vision is a participative process, involving all relevant stakeholders.

2.3. Analysis of the current situation of the region

Sustainable regional development hinges on the idea that regions are integrated systems with a natural and social dimension. This connects to the socio-ecological systems (SES) framework (Ostrom, 2007, 2009). The SES framework, which is used in this research to systematically analyze and describe the current situation of the regions, is an integrative and multi-disciplinary framework for analyzing different (social, economic, ecological and governance) aspects at internal and external levels of a system. It also looks at their interactions and outcomes.

The SES framework defines the interaction between four sub-systems namely [resource units (RU), resource system (RS), governance system (GS) and users (U) (Fig. 3). As a result of the linkages between the different sub-systems, there are outcomes delivered as well as interactions with the social, economic, and political settings within the SES system. Ostrom proposed 53 second level variables that could be used to analyze the main features of each sub-system. However, some of these 53 variables are not applicable in all cases. As a result, for each specific case the relevant second-level variables were identified. For this research we combine both the original definitions as well as the adapted descriptions of the variables by Delgado-Serrano and Ramos (2015). In this paper we summarize the variables on the first (general) level.

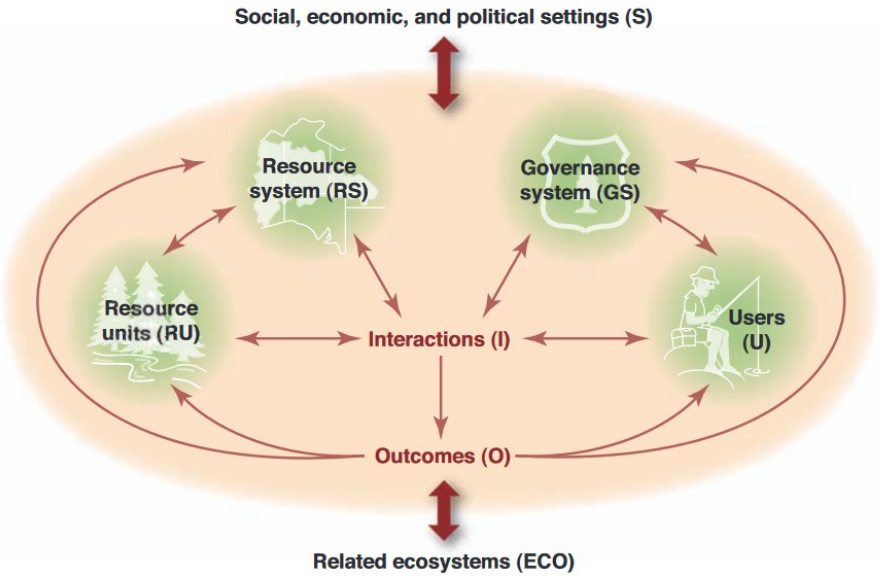

Fig. 3. Framework for analyzing sustainability of social-economical systems (Ostrom, 2009).

2.4. Development of Innovations

Systemic change, is a result of interplay of a variety of changes at different levels and in different domains that in a particular way somehow connect, interact, and reinforce each other to produce a fundamental change in a system (Loorbach et al., 2017). This is based on the multi-level perspective (MLP) (Geels & Schot , 2007). This multi-level perspective of transition highlights the concept that transitions are a process of innovations and are non-linear and are the result of interactions at multi-levels. The MLP defines three levels relevant for transitions: the niches level, the regime level, and the Landscape level (Geels, 2005). The central focus of the MLP framework is the socio-technical regime, which encompasses the established systems that impose path-dependent incremental sociotechnical change (Geels, 2002). It is important to note that the multi-level perspective theory argues that transitions come about through interactions between processes at these three levels. Alignment of the three levels enables the breakthrough of novelties in mainstream markets where they compete with the existing regime.

The transition pathways developed in this project combine the MLP theory and the X-curve theory. According to the X-curve theory, transitions are an iterative process of building up and breaking down (Loorbach, 2017). Based on the combination of these two theories, innovations were formulated to target the following sub-elements of the socio-technical regime: governance, technology/management, economic/business models, competences and socio-cultural. In any transition innovations will follow one of the lines of the X-curve (fig 4.). It can either follow the line of emergence and build-up, transform the existing or breaking down and phasing out. In general, it is important in this step to address the question of which practices need to be adopted, developed and/or need to be phased out.

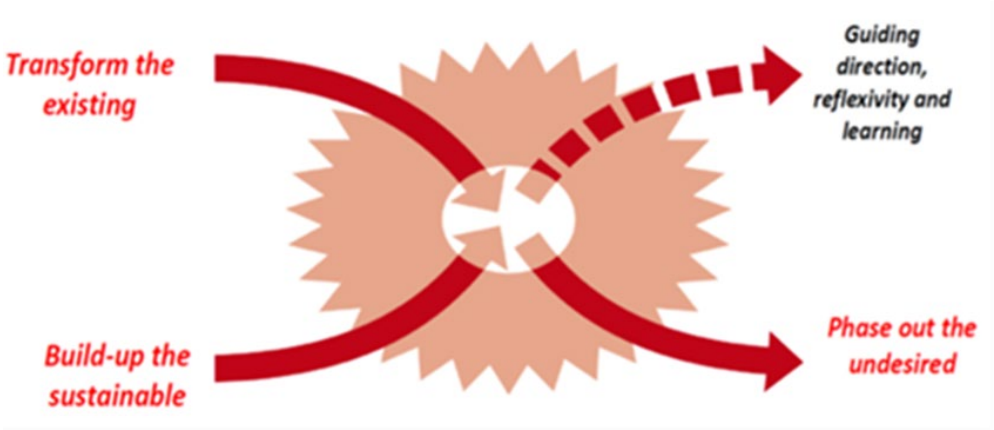

Fig. 4. Development of scenarios with timelines for innovative actions to reach the vision (Loorbach et al., 2017).

2.5 Scenario development

Scenario development is key for prioritizing, managing, and guiding the transition pathway. For scenarios for the transition pathway, it should be clear which innovations (either to be implemented or phased out) need to start and which ones follow, i.e. a clear timeline of innovative actions and approach towards contribution to the vision of the region. The scenario development should also be aligned with available resources such as monetary and labor. Scenario development should be based on an extensive assessment of budgetary requirements, present regulations, technical capacities, feasibility etc. This exceeded the scope of this research project.

2.6 Development of critical success factors

The final phase in the development of a transition pathway would be to identify where the major barriers and risks lie in the process of development and implementing of the transition pathways. Identification of opportunities and threats on a regional, provincial, and national level is crucial as this can influence the success of the transition process. For the critical success factors, relevant interactions described by Ostrom (fig 3.) were identified and for each interaction the success factor was determined. The success factors were grouped, based on the X-curve of Loorbach (fig. 4). These success factors identified the topics the region and its stakeholders need to work on to achieve the desired systemic change.

3. Results

3.1. Case studies

The methodology/analytical framework described above was applied to the seven European regions where INVEST4EXCELLENCE living labs were located. Furthermore, each of these living labs focused on a particular question related to how to attain systemic change for a sustainable region. The case studies and their main focal action point are listed in Table 1. The living lab regions that were chosen for this study were part of the INVEST4EXCELLENCE project, and each region had a different nature and context. We looked at transition pathways for spatial living labs, except the living lab in Bulgaria that was a virtual living lab.

In this results section, we will describe the transition pathways that were developed in each living lab and then make comparisons between the different transition pathways. The descriptions for the different pathways are not exhaustive but are summarized to cover the fundamental issues.

Table 1. The seven case studies and their focus areas.

	Living lab Region	Focal Action Situation
1	The Netherlands - Bronckhorst	Aligning bottom-up and top-down strategies for Nature Inclusive Farming.
2	The Netherlands - Delta-East	Combine societal, economic, logistic, and environmental interests with climate proof river area design.
3	The Netherlands - Friesland	Transition towards sustainable water management and land-use in peatland areas.
4	Bulgaria – Virtual living lab	Family business and family business transfer and succession in organic agriculture.
5	Greece – Thessaly	A resilient response system in the post-disaster phase (storms/flooding, forest fires, earthquakes).
6	Slovakia – Nitra	Building a sustainable regional food-beverage system.
7	Finland - Karelia	Climate sustainability, responsibility and clean solutions, viable future, and sustainable regional development and accessibility.

3.2. Transition pathways

A uniform format for the transition pathways for all regions was given during a project kick-off session. Thereafter, each living lab team followed its own process of developing its specific the transition pathway. In this section we describe the resulting pathways that were developed.

3.2.1. The Netherlands – Bronckhorst

The living lab in the Netherlands in Bronckhorst is in the east of Netherlands and is a rural agricultural region in the province of Gelderland in the Netherlands. For this living lab, the development of the transition pathway was led by Van Hall Larenstein University of Applied Sciences. In the living lab stakeholders from government, industry, education, and research as well as society were active and well represented.

Region for transition pathway: For the transition pathway, a specific choice was made to focus on the administrative region of the Municipality of Bronckhorst.

Description of the vision: The stakeholders generated a vision that sought to develop a vital landscape that comprises of nature-inclusive farming with a viable farming community.

Regional Analysis:
Table 2 provides a summary of the analysis of Bronckhorst, The Netherlands conducted based on the SES framework (Ostrom, 2007). This analysis is done using relevant variables selected from the 53 second level variables.

Table 2. Regional Analysis Bronckhorst, The Netherlands	
Resource System	The region comprises of 286 km^2 with highly specialized dairy farms. The water quality exceeds the standards of the EU-Water Framework Directive.
Resource unit	Income in the region is mainly generated from milk production and providing eco-system services.
Governance systems	Many government policies and legislation that impact activities in the region. The region has a lot of different farmer organizations with some doing similar activities.
Actors	In the region there are a lot of farmers. Most workers (and work) are in the Agro-food sector.

Innovations : To ensure that the region transitions towards a vital landscape with nature inclusive farming with a viable farming community, it is proposed to develop farm management strategies for Nature Inclusive, Circular Farming. The farmers will need to change their focus on just product quantity and quality towards environmental and social impact and values. For governance, there is need for new participative, area specific policies.

Critical Success factors:
Table 3 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 3. Living Lab Bronckhorst: Towards Nature Inclusive Agriculture	
Adapt	Develop area-specific goals for emission of N, herbicides and pesticides and enforce these through effective verification and monitoring by monitors that are accountable to both governments and farmers.
	Reward farmers for ecosystems-services with long-term agreed payments for achieving clear goals, instead of short-term subsidies for detailed measures.
	Actively engage in field-lab activities and be prepared to reflect and develop, adapt, or abolish regulations
	Align policies, communication, regulation, and implementation from different governments as best as possible.

Develop new	Design a price policy that guarantees a profitable margin for farmers
	Oblige retailers to be transparent about the division of margins in food-value chains.
	Invest in formal and informal trust-building activities.
	Recognize the right by local stakeholders to self-governance within pre-defined boundaries.
Stop	Remove obstacles related to prohibiting state aid to farmers for sustainable investments.

3.2.2. The Netherlands – Delta East

The living lab Delta East covers the covers the urbanized river area of Arnhem and Nijmegen where the river Rhine splits into the Waal, Lower Rhine and IJssel in the province of Gelderland, The Netherlands. The area covered by the living lab has interests in many sectors including, agriculture, urbanisation, nature and recreation, mineral extraction and shipping. Public-private-people partners (4ps) participate in the living lab, with van Hall Larenstein university of applied sciences being in the lead.

Region for transition pathway: The physiographic region of the urbanized river area of Arnhem and Nijmegen was chosen for the transition pathway. The pathway covers an area that is beyond the administrative boundaries.

Description of the vision: The vision for a sustainable delta east was to develop a future-proof water system with nature as a basis for design and with societal functions as guest.

Regional Analysis:
Table 4 provides a summary of the analysis of Delta East, The Netherlands, based on the SES framework (Ostrom, 2007). This analysis was performed using relevant variables selected from the 53 second level variables.

Table 4. Regional Analysis Delta East, The Netherlands	
Resource System	The physiographic region is a total of 3,800 km^2 river area of Arnhem and Nijmegen that is not-yet climate proof. There are many interests: shipping, mineral extraction, agriculture, urbanization, nature, and recreation.
Resource unit	A landscape shaped by a complex interaction between all interests that a mentioned in the resource system.
Governance systems	Various government departments and layers develop a shared vision. They are directed under government statutes on how to operate.
Actors	A diverse group from different parties with interests in the region: knowledge institutes, companies, citizens, and governments.

Innovations: Innovations that have proposed for a future-proof water system include Collaboration towards an integrated vision instead of opportunistic activities. This would be also further supported by an active participation of citizens. For implementation of projects in the area, methods for working be should in a multi-actor setting.

Critical Success factors:
Table 5 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 5. Living Lab Delta East: Combine interests with climate proof river area design	
Adapt	Adapt the management of the knowledge infrastructure of Living Lab Delta East to accommodate it for long term transitions. For example, referred websites of finished projects are no longer accessible.
	Focus on multi-actor sessions.
	Ensure continuous publications and contributions at conferences and expert meetings.
	If major actors leave (which happens regularly) find replacements who are as enthusiastic and motivated on taking over their role and pay attention to transfer of information to successors.
Develop new	Research on how to best involve citizens considering their position and issues around power dynamics and stakeholder fatigue.
	Ensure a structural availability of (Master) students to participate in Living Labs.
	Develop visuals (for example Visual problem Appraisal) for learning and discussion in formal and informal environments.
	Develop methods for working in complex multi-actor settings.
Stop	Undervaluing of citizens.

3.2.3. Living Lab Friesian Peatland – The Netherlands

The Living Lab Frisian Peatlands focuses on this transition towards sustainable water management and land-use in the peatland areas in the Dutch province of Friesland, involving all stakeholders, and considering the multilevel governance of Sustainable Development Goals.

Region for Transition pathway: The physiographic region of peatland meadow area in the central and southwestern part of the province of Friesland.

Description of the vision: a vital region and agro-economy, based on circular principles and sustainable land and water-use, while safeguarding livelihoods, biodiversity, an attractive landscape, and good water and soil quality in the region.

Regional analysis:
Table 6 provides a summary of the analysis of Friesian Peatland, The Netherlands, based on the SES framework (Ostrom, 2007). This analysis was performed using relevant variables selected from the 53 second level variables.

Table 6. Regional analysis Friesian Peatland, The Netherlands	
Resource System	The physiographic region covers 850 km^2 in which grasslands (60% grassland used for dairy farming), lakes, nature areas and buildings alternate constantly. As a result of peat oxidation, the soil subsidence rates amount to approximately 1 cm per year on average and oxidation leads to CO_2 emissions. Water quality is not meeting the EU Water Framework Directive.
Resource unit	Intact and functioning peatland ecosystems provide many ecosystem services. Currently the yield of intensive grassland for dairy is around 12-ton DM[1]/ha/year - whilst their emission factor is at 36 ton CO_2-eq/ha/yr.
Governance systems	The regional authorities in Friesland designed the Peatland pasture program 2021-2030, encompassing EU and national regulations.
Actors	The program was launched by the Province of Friesland and the Water Authority of Friesland. Various environmental NGO's and Farmers' associations are active in the region. Also, the ministry of Agriculture, Fisheries, Food and Nature is directly involved.

[1] Dry matter

Innovations: A more general understanding of the challenges regarding rewetting drained peatlands and how sustainable use of peatlands can help with various other challenges. Uncertainties regarding viable business models for farmers who want to rewet are currently posing barriers. Extensive dairy farming practices need to be profitable for farmers, new sustainable business models and pricing policy based on ecosystems services are needed. Technological advances in farming equipment and adapted water management schemes can support dairy farming on high groundwater levels.

Critical success factors:
Table 7 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 7. Living Lab Friesian peatland: extensive dairy farming on rewetted peatland	
Adapt	Knowledge sharing and co-creation to sustainably manage peatlands.
	Intensify facilitation of bottom-up "area processes" with platform meetings between stakeholders.
Develop new	Stable policies and long-term (policy) vision.
	Subsidize sustainable products to incentivize consumers to buy these products, while providing access to income ranges.
	New business model developments for paludiculture or wet farming that incorporates other ecosystems services.
	Technological advances in farming equipment and adapted water management.
Stop	Investments schemes and loans focusing on maximizing outputs.

3.2.4. Living lab Bulgaria -Plovdiv

The living lab in Bulgaria was originally developed to focus on the South-Central region of Bulgaria that is made up of 48.1% of agricultural land, 45,1% natural reserve and 3.9% urban areas. The issues that this living lab seek to address are perceived to be a common issue in Bulgaria. Involvement of the public-private-people partners (4ps) is to a limited extend and the University of Agribusiness and Rural Development is in the lead of the living lab.

Region for transition pathway: The transition pathway was developed for the whole country of Bulgaria. The pathway will take place through a virtual network that will initially focus on the administrative regions of South-central region and the North central region; however, the findings should be accessible for use in all the Bulgarian regions.

Description of the vision: Succession issues in agriculture are a major issue in agriculture, especially in organic agriculture. The transition pathway seeks to develop resilient family businesses within a cross-sectoral ecosystem. These are mainly sustainable production, natural & cultural heritage, new business models, green urban & rural development, accessible public services & capacity development.

Regional Analysis:
Table 8 provides a summary of the analysis of Plovdiv, Bulgaria conducted based on the SES framework (Ostrom, 2007). This analysis was performed using relevant second level variables selected from the 53 second level variables.

Table 8. Regional Analysis Bulgaria, Plovdiv	
Resource System	The targeted region for the transition pathway is a 41,577 km^2 administrative region with favorable cultural, scientific, natural, and climatic conditions to develop (organic) agriculture, quality food and tourism.
Resource unit	Agricultural produce (organic produce more specifically) is sold mainly as raw products. There is low level of processing activities and value addition. On the farms there is a limited number of farm livestock.
Governance systems	Local authorities engage in community-led local development and the non-governmental sector is well-developed. It is observed that legal frameworks sometimes are inflexible and restrictive.
Actors	A lot of knowledgeable and motivated farmers, passionate about agriculture. Several initiatives of local communities and producers' organizations.

Innovations : Innovations that were proposed to develop a more attractive agriculture to current and future farmers. This can be through development of training curricula for organic farming. Also, attention should be on quality assurance in production and process control rather than only on final products. Farmers markets can be used as a ground of innovation. Resources and energy should be allocated towards cooperation and network development.

Critical Success factors:
Table 9 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 9. Living Lab Bulgaria: Family business in organic agriculture	
Adapt	Funding for institutes to create and maintain organic seeds, compared to quality grain seed programs.
	Provide accessible support and advice on the EU 2022 rules on organic products.
	Further development of training curricula based on definition of major learning outcomes on organic agriculture.
	Foster specialized managerial skills in research and innovation.
Develop new	Develop (financial) measures to support the transition period and investments for entrepreneurs to organic farming.
	Encourage production processes that are labor intensive.
	Funding for institutes to create and maintain organic seeds.
	Encourage networking in the organic sector.
Stop	Inflexible local rules that impede subsidies if different crops on the same plot are grown.

3.2.5. Thessaly – Greece

The living lab in Thessaly was inspired by the thinking that knowledge for disaster risk reduction is an integral part of social and economic development for the sustainable future of the region. The living lab is established through the lead of University of Thessaly, in Greece. Within the living lab, the quadruple helix partnerships include, research (local universities) , education (students and researchers) , local authorities (Regional governance of Thessaly, Municipality of Larissa) and companies (including IT companies).

Region for transition pathway: The transition pathway was developed with and limited to the administrative region of Thessaly.

Description of the vision: The vision of the stakeholders in the region was to develop a region that adeptly responds to crises due to extreme weather patterns. The region should emerge as a symbol of resilience and innovation in post-disaster recovery. The strength should be facilitated by a systematic approach, bolstered by Big Data insights, AI-driven predictive capabilities, and IoT networks.

Regional Analysis:
Table 10 provides a summary of the analysis of Thessaly, Greece conducted based on the SES framework (Ostrom, 2007). This analysis was performed using relevant variables selected from the 53 second level variables.

Table 10. Regional analysis Thessaly, Greece	
Resource System	Thessaly is a 14,036 km^2 region that is very vulnerable to seismic activities, floods, and forest fires. As a result of floods, infrastructure especially that close to the rivers, are constantly under threat. Risk areas include, lakes, reservoirs as well as biodiverse forests in the region. For the living environment, water and sewage water can be affected in the case of extreme conditions. On the other side, the University of Thessaly, is highly active and equipped with advanced ICT technologies.
Resource unit	Thessaly is a region where there are lot of initiatives by different stakeholders to integrate ICT technology in different activities. The region has lots of collaborative initiatives in developing new projects.
Governance systems	A lack of a central orchestration of policies and regulations on ICT technologies. Low national and regional regulations. Existing regulations are fragmented.
Actors	A lot of active government agencies, NGOs, and private companies active in the region and working on creation of disaster resilience.

Innovations: To develop a region that adeptly responds to crises there is need to focus on Intelligent capabilities optimizing response efforts across diverse scenarios. Furthermore, there is a develop a semantically enhanced interoperability agent (an Artificial Intelligence system) with a comprehensive knowledge base, tailored to autonomously gather information and generate optimal response plans for various types of disasters. For success, resource need to be further invested in technological advancements on data integration and management, AI-models, Blockchains, Virtual Reality, Decision-Making Platforms.

Critical Success factors:
Table 11 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 11. Living Lab Thessaly: Resilient and innovative post-disaster recovery	
Adapt	Ensure the active involvement and commitment of all stakeholders through workshops, feedback sessions, and co-creation.
	Ongoing investment in technology upgrades and training to adapt the technology to future challenges.
	Ensure adequate and sustained funding and resource allocation to support the operations, research, and development activities within the Living Lab.

Develop new	Effective integration of the Living Lab's initiatives with regional and national policies.
	Build a resilient community that includes marginalized and vulnerable groups in planning and decision-making processes. Ensuring that the benefits of innovation reach all segments of the population is key to holistic regional resilience.

3.2.6. Nitra, Slovakia

The living lab in Nitra, Slovakia focused on agri-food systems, which was inspired by the development of new regional integrated spatial plan for Nitra region. In Nitra region addressing sustainability and climate issues as well social cohesion is of paramount importance for different stakeholders. In the Living there is active participation of public-private-people partners (4ps). The Slovak University of Agriculture (SUA) was in the lead in the establishing of the living lab.

Region for transition pathway: The transition pathway was developed and limited to the three districts (Nitra, Levice and Nové Zámky) of the Nitra region. The boundaries of these three districts are based on the administrative regions of the government. The three districts were selected because of their different character.

Description of the vision: The ambition for developing the transition was to develop a region with sustainable regional food systems that prioritizes the well-being of its inhabitants while safeguarding the environment. Production of food and beverages should not be focused and restricted to export but producing for local consumption and regional food safety while ensuring circularity and integrity of the social– ecological system.

Regional Analysis:
Table 12 provides a summary of the analysis of Nitra, Slovakia conducted based on the SES framework (Ostrom, 2007). This analysis was performed using relevant variables selected from the 53 second level variables.

Table 12. Regional Analysis Nitra, Slovakia

Resource System	The three districts addressed in Nitra region cover 3,729 km^2 where agriculture plays an integral part of the local economy. The region has soils and climatic conditions suited for farming.
Resource unit	High quality agricultural land, 78% of land used by commercial companies, cooperatives, and state-owned farms. Most of the produce is not consumed locally but rather produced for export. The main crops produced are wheat, barley, maize, oilseeds, grapes for wine production as well as various fruits and vegetables.
Governance systems	High involvement of ministries and municipal government in the agricultural sector. To support different activities there is a Regional Development and Information Center. Several social enterprises are now active in the region.
Actors	All three districts have Local farmers markets supported by municipalities. In Nitra region there is an active slow food Network. Next to Slovak University of Agriculture, there are several other educational and farmer support institutions with a strong connection to agriculture in Nitra.

Innovations : For the region to develop a sustainable regional food system, there is need for food producers to consider implementing regenerative agricultural systems. Furthermore, the different agricultural institutions in the region can be incorporated in the development of a strong agricultural advisory system for not only production but also int the value chain. The distribution systems of local food and beverages can be used and improved. Also, different networks and

association should take an active role in the development of a sustainable food system. Such a system would comprise local processing factories, the university's food incubator and breweries. Municipalities to support dis-advantaged communities and practice social farming.

Critical Success factors:
Table 13 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 13. Living Lab Nitra: a sustainable regional food system	
Adapt	Engage strong leaders and motivated actors in municipalities, who are strongly linked to local agriculture and food producers.
	Allocate resources from state and Europe public social and nature-based innovations.
Develop new	Support collaboration and transparent communication among stakeholders.
	Develop expertise.
Stop	Remove legal and regulatory constrains for transformation of agricultural advisory system.

3.2.7. Karelia, Finland.

The living lab Karelia mainly focuses on energy use and seeks to promote the use of renewable energy and production of sustainable energy. This is driven by the fact that Karelia region has a biosphere reserve. The living lab has been initiated by Karelia University of Applied Sciences. Transdisciplinary collaboration in a quadruple- helix forms part of the essential elements of elements of the living lab where a natural way of working is promoted. This living lab is one of the four living labs where most of the partners are active, each with a different focus.

Region for transition pathway: The transition pathway was developed to focus on the UNESCO North Karelia Biosphere. To make it easier for all the partners and stakeholder, the administrative province of North Karelia was considered.

Description of the vision: The vision of the stakeholders in the region was for regional sustainable development through strong stakeholder cooperation through strengthening research, development, and innovations in the field of renewable energies. .

Regional Analysis:
Table 15 provides a summary of the analysis of Karelia, Finland conducted based on the SES framework (Ostrom, 2007). This analysis was performed using relevant variables selected from the 53 second level variables.

Table 15. Regional Analysis Karelia, Finland	
Resource System	The North Karelia biosphere is in total 21,858 km^2 . Use of energy from different sources. Renewable energy production operations are either large-scale energy plants or smaller-scale decentralized energy production – for example energy communities.
Resource unit	Serious concerns on use of non-renewable energy sources such as peat. Renewable energy sources are on the rise but not quickly. Renewable energy from different sources (wood-based materials, hydro, wind, solar, heat pumps, geothermal, biogas, energy from waste materials) are used. Proximity of Russian border prevents establishment of wind plants.

Governance systems	Basic governance is through the regional council of North Karelia, Municipalities. But many different bodies involved in various permits that are required for production of renewable energy. Governance system is a complicated network with several processes, depending on the energy source and the scale of operations.
Actors	Citizens, housing communities, Local organizations and companies, Municipalities and other public sector, farms, and communities.

Innovations: To ensure there is a swift move towards renewable energy there is a need to promote circular energy, use of locally available and produced locally energy. Digital technology as well as citizen science can play an active role. There is need to invest in research on renewable energy: looking into grid capacity, energy storage and efficiency. Sharing of knowledge on renewable energy as well as energy counselling is important for the region. For community projects, festivals, and public projects it is necessary to promote use of renewable energy. Furthermore, there is a need to better connect research to business to ensure that there is development of sustainable business models.

Critical Success factors:
Table 16 contains the critical success factors essential to achieving the transition pathway vision. To be able to successfully implement the innovations developed, the issues stated below need to be addressed. This may involve adapting current practices, developing something new or stopping certain practices.

Table 16. Living Lab Karelia: Towards climate sustainability and a viable region	
Adapt	Education offerings to better fit the fast-developing field.
	Main electricity grid and high enough grid capacity throughout the country.
	Means for demand response.
	Educating citizens, communities, and landlords on energy communities.
Develop new	IPR-related competences.
	Education in maintenance, ICT, automation, energy transmission and integrations.
	Financial support for innovations.
	Increase communication on possibilities towards public.
Stop	The dependency on peat as energy source.
	Slow permitting processes delaying development.
	Subsidies for fossil fuels.
	Insufficient long-term support for RDI.
	Inefficient energy consumption practices.

4. Discussion and conclusion

In this project, the approach for developing transition pathways is based on three theoretical building blocks. First, the ABCD-Roadmap that outlines the various steps to be developed in the design process of the transition pathway. Secondly, the Socio-Ecological-System framework was used to describe the current situation and analyze the interactions within the system. Based on the comparison of the current situation with the vision, innovations needed could be formulated. Lastly, the X-curve model provided guidance in categorizing activities and policies that should be adapted, developed new or stopped. The international team showed how transition pathways for sustainable development in seven different European regions can be developed.

It is important to note that the developed transition pathways are initial prototype transition pathways that are not yet implemented in a particular region to effect the actual systemic change

the region seeks. The development of a transition pathway should be seen as an interactive, cyclic process of design – check/test – evaluate – re-design etc. This implies that the developed pathways need several evaluation and re-design steps. Development of transition pathways requires a co-creative management approach (Roorda & Wittmayer, 2014), that should be supported by a transitions support system, integrating decision support tools and stakeholder analyses (Dijkshoorn-Dekker et al., 2019). Such a support system should be holistic and integrate knowledge from various perspectives (Iatrellis et al., 2023).

Transitions can take up to decades since new innovations will destabilize the existing regime and achieving a new stability takes time. The timing of interactions between the different levels as defined by the MLP framework is a crucial factor (Elzen & Hofman, 2007). Transitions need a space for different stakeholders to undertake activities that result in systemic change towards sustainable development. Time and room are needed for niche innovations to have impact on and change the incumbent socio-technical regime. Furthermore, time is needed for stakeholders to broadly agree. For a transition to take place we need a platform that facilitates systemic change through different activities (Rotmans et al., 2007). A long-term ambitious vision creates a direction for a joint agenda between stakeholders as well as an opportunity for scaling up experiments to enhance possibilities of breakthroughs (Ibid.). In this research we developed transition pathways for 2035 as this timespan seems realistic for farmers and entrepreneurs.

The case studies showed how, by working using a regional focused approach, we were able to propose transition pathways that can integrate different dynamics towards solving a particular challenge in a specific region. A lot of research on transitions and transition pathways have been focusing on sectoral transitions. These include the energy transitions (Heijnen, 2022; van Dam et al., 2021), the protein transition (Pyett et al., 2023), the fashion industry (Buchel et al., 2018) and the health care transition (Johansen, 2023). There has been to a limited extend the consideration of geographical and regional dimensions of a transition. This perspective also allowed us to realize that actors in different sectors do not operate in silos. Transdisciplinary collaboration is a significant element for achieving more sustainable development (Lehtonen et al., 2018). In a regional approach, actors can be better linked to each other, and stakeholders can better influence the transition process. This is illustrated by the diversity of the innovations that were proposed in the transition pathways in the case studies. The innovations were not only limited to technical issues but also included innovations in social, economic, governance and competence's themes.

Regional transition pathways can be developed on different scale levels, for different types of regions. In the INVEST4EXCELLENCE project, pathways were developed for both physiographic and administrative regions. The scale level varied from municipal (Bronckhorst) to large administrative districts (Plovdiv). From our research, we observed that the regional boundaries of a transition pathways are defined by the focal action situation or the main issue that the living lab sought to address. Environmental oriented issues such as river-management or peatland management choose physiographic regions, while (agricultural) development-oriented issues choose administrative boundaries.

A clear, common vision or perspective is important for formulation of a transition pathway, as it is the unifying direction to go. However, the crucial question in our research was how to develop a comprehensive vision, that all stakeholders can agree with. Based on the quadruple helix approach, all cases formulated the vision from a multi-stakeholder perspective. Next to multistakeholder participation, it is also important to start with an analysis of existing vision documents, stakeholders acting on the similar transition and government policies that are

focusing on the same transition pathway. From these “low hanging fruits” there is less resistance for the development of the transition pathway. The vision can then be further developed from these perspectives. The transition pathway should combine top-down and bottom-up strategies. This also energizes and motivates the stakeholders involved early in the process. The development and involvement of communities or local stakeholder networks was identified as a success factor in all case studies. What is most important is that the vision is clear, easy to understand and energizes all the stakeholders involved.

To develop the appropriate innovations for working towards the vision of the region in a transition pathway, it is essential to have a deep understanding of the current situation. For this research, the SES framework (Ostrom, 2007) proved to be appropriate. From our research we observed that the second-level variables are the most suitable for the regional analysis. Ostrom identifies 53 second level variables. However, it is acceptable to select the variables that are applicable in the specific case. (Delgado-Serrano & Ramos,2015). None of the seven case studies used all 53 second level variables, which demonstrates that all the 53 second level variables may not always be relevant to a specific transition pathway.

Innovations and policy advice in a transition pathway need to be aligned to the context of the regions. Furthermore, the innovations need to applicable to different stakeholders. The different transition pathways that were developed during our research differed from technical innovations, social innovations to governance innovations. However, for every transition pathway, the innovations differed in focus (technical, social or governance) per pathway. All regional transition pathways identified governance innovations necessary, such as adjustment of regulations, procedures for permits and allocation of resources and subsidies. Those pathways that incorporated an environmental dimension, like energy in Karelia, peatland in Friesland, water in Thessaly or nature in Bronckhorst also emphasized technological innovations, while more development-oriented pathways (Plovdiv, Nitra) focused on governance. The pathway Delta-East focuses on learning and social innovations.

The most challenging issue in developing transition pathways is phasing out and stopping unsustainable practices, or practices that do not lead to or block systematic change. We notice that there were limited proposals on practices to phase out. However, if some practices are not phased out, the likelihood of developing space for new innovations is low. The model of Ostrom comprises interactions between variables and outcomes of these interactions that determine successful systemic changes for sustainable development. Success factors and policy advice can be drawn from the assessment of these interactions and outcomes. However, due to the complexity of the challenges which are faced in the regions, this proved to be not always easy. The appraisal of regional interactions and outcomes based on Ostrom’s framework and relating the results to success factors and advice is a field for further research.

Transition trajectories are whimsical processes, that follow crooked courses, that have interactions between technical and social changes as well as alternating slow and fast dynamics (Elzen et al. 2020; Rotmans et al., 2007). Due to these complex dynamics of transitions, transition pathways should not be viewed as blueprints to achieve sustainable development. We view transition pathways as a compass to guide stakeholders in a region towards sustainable development and to create a common direction for development. The challenge of developing a transition pathway is to formulate a pathway that unifies all stakeholders on a common perspective, leaving room to a diversity of views, characteristics, and activities.

As stated above, the transition pathways in this paper are prototypes for discussion. A future step would be to discuss and redesign the transition pathways together with stakeholders who will be directly and indirectly impacted by the developed innovations. This will involve the different quadruple helix partners, in the living labs where co-creation and co-learning are central elements for effecting systemic change (Witteveen et al., 2023). An essential theme is inclusiveness in the sense of levels in society, positions, as well as gender, as not all societal groups are equally equipped to participate actively. Transition processes focus on motivated stakeholders and through help of perceived leaders or spokespersons more and other groups of stakeholders could become involved. The development of a transition pathway is not the responsibility of only one stakeholder but rather a multi-actor process (van der Brugge & van Raak 2007). The transition pathways in this project were mainly developed by knowledge institutes and should be followed by regional transdisciplinary processes, thus contributing to a more sustainable Europe.

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