



Transdisciplinary Field Research Training

Resilient Sustainable Communities

Sankt Pölten | Langau, Austria

Final Report

April 2023



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Transdisciplinary Field Research
Resilient Sustainable Communities

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Abstract

There is ample availability of research and studies that focus on sustainability in cities and urban policies that is also directed by UN's Sustainable Development Goals, number 11 aiming at sustainable cities and communities. This report shifts this dominant focus by attempting to add to the body of research that highlights the need and strategies for sustainability in small towns and rural areas. This research applies a condensed version of the Transdisciplinarity Field Research Training to the case of Langau, a town of 700 people situated on the border of Austria to Czech Republic. The research is aligned to seek orientations to the guiding question: "How can the community actors of Langau improve the adaptive capacity of its social infrastructure for the next 20 years?"

The project was conducted in 6 phases: comprehending theory, development of guiding question and system model, contacting stakeholders, preparation, stakeholder conference and analysis and reporting. A transdisciplinarity process was applied for the first five phases of this process while the SVIDT method involving only the facilitators was used for analysis and evaluations. The result of these applications and processes led the team with the 128 scenarios of which the facilitators chose three as most plausible: health crisis, societal breakdown and economic downturn. It was deduced that Langau is most vulnerable to an economic downturn (19%) and least vulnerable to a health crisis (6%) while it has the highest adaptive capacity to deal with a societal breakdown and the least adaptive capacity against the health crisis scenario. Following this, the facilitators outlined seven interventions for Langau to build its capacity to adapt to various threats over the next 20 years: i) Increased investment in community nurse projects to attract further nurses ii) Building a small healthcare facility through regional initiatives to serve Langau and neighbouring towns iii) Improving infrastructure to attract more remote workers. iv) Improving infrastructure to attract more tourists. v) Incentives for new businesses starting in Langau. vi) Grassroot level community initiatives on environmental regeneration. vii) Training and investment into resilience measures against climate change

Keywords: transdisciplinarity, TD process, SVIDT, Langau, adaptive capacity, social infrastructure

Abbreviations

EC	Evaluation Criteria
GQ	Guiding Question
IF	Impact Factor
TD	Transdisciplinarity
TFRT	Transdisciplinary Field Research Training
SoROs	Socially Robust Orientations
FSA	Formative Scenario Analysis
MCA	Multi-Criteria Assessment

1. Introduction

Defining a city in terms of urban or rural settings has always been a difficult task. Some institutions define it in terms of minimum population size, some leave it to the administrative decision. Some countries use the provisions of infrastructure or employment as an indicator to classify a city as urban or rural (Dijkstra et al., 2023). Many organisations have tried to define a city using certain characteristics, but no one rule can fit such varying countries differing in demographics across the globe. However, there is a need to develop a globally mutual and agreeable definition for a city and indicators to achieve SDG 11, which focuses on making cities, and human settlements inclusive, resilient, sustainable, and safe to address the contemporary challenges cities face such as climate change, unemployment, environmental degradation, etc (United Nations). Another important aspect that needs to be considered is what a healthy city looks like to make them sustainable. The World Health Organization defines a healthy city as a ‘space that involves the ongoing development and enhancement of both the physical and social surroundings, as well as the expansion of available community resources to facilitate mutual support and enable individuals to achieve their full potential in all aspects of life.’ Community development in terms of healthy sustainable cities should be taken from the perspective of the 6 P's i.e. people, participation, prosperity, planet, place, and peace (World Health Organization, n.d.). In the face of varying global challenges, it is now even more prudent to work our way towards sustainable cities and communities that can adapt to these current issues.

Therefore, the study “Resilient Sustainable Community of Langau” uses the Transdisciplinarity (TD) approach to analyse and evaluate the risks and vulnerabilities of Langau, a small town located in district Horn sharing a border with Czech Republic. The TD approach is based on mutual learning among scientists and practitioners considering complex and socially relevant problems. The goal of the TD process is to build socially robust orientations (SoROs) about real-world complex issues which can later be used in the decision-making process by the stakeholders involved in the process (Scholz & Steiner, 2015). The SVIDT method is used as a framework for managing [digital] threats and vulnerabilities within a system. This method identifies and visualises threats and vulnerabilities through multi-level system actor analysis, formulating threat scenarios that could be plausible, and

then puts forward the intervention scenarios for these threats, which helps increase the resilience of coupled human-digital environment systems (Scholz, 2017).

In pursuit of exploring the TD method, the project team worked on two cases. The first case involved the city of St. Pölten but it encountered several challenges and was subsequently discontinued. The case is briefly discussed in this report as Case 1. The second case involved the town of Langau and was successful. It is described in this report as Case 2 and will be discussed in depth as the focus of this report.

1.1 Case 1: Sankt Pölten

1.1.1 Guiding Question

The case of St. Pölten was initiated by Prof. Heiki Köckler who specialises in urban planning and environmental justice. The project team conducted initial research about major disaster threats in Austria which revealed that it is prone to flooding. Looking through this angle, the SENDAI framework for Disaster Risk Reduction developed by the UNDRR (United Nations Office for Disaster Risk Reduction) was a point of reference on how to strengthen the city of St. Pölten against disasters. As a result, during the Transdisciplinarity Field Research Training workshop in January 2023, a first guiding question was devised as follows:

“How can we (St. Pölten local government) improve the (post-disaster) resilience of St. Pölten city in the face of recurring flooding in the next 10 years?”

In February 2023 the guiding question was revised by the project team, to take a holistic approach towards a healthy city development and consider various actors besides just the local government (hence the addition of social and institutional systems). The revised question was as follows:

“How can the social and institutional system of St. Pölten improve the resilience of the city by the example of recurring floods and understanding the management of it as one aspect of it in the next 10 years?”

1.1.2 System Analysis

By virtue of being situated along the Traisen River between the foothills of the Alps and the Danube River, west of Vienna, St. Pölten has been prone to flooding events which have caused major disruptions. The system boundaries were defined by keeping actors and elements that chiefly affect and are affected by such disaster events, while acknowledging St. Pölten’s position in the broader context of region, country and the EU.

The SENDAI framework of the UNDRR ‘recognises the State as the principal role in reducing disaster risks but the responsibility should also be shared with other stakeholders including the local government, private sector and others’ (UNDRR website, n.d.). The project team identified the city council and administration of St. Pölten as the organisation to liaise with and also as a stakeholder. Keeping in mind economic, social, cultural, political, physical, and environmental domains, other stakeholders identified for this project were transport systems, healthcare and medical facilities, the meteorological institutions, evacuation planning teams including firefighters, planners, water engineers, police, nature protection and land management agency.

In the broader context, laws and policies that govern Lower Austria have a vital role to play in how St. Pölten, the region’s capital, receives resources and can implement newer strategies towards any issue. The same is extended to the country and the European Union at large. These dependencies were considered to chalk out how the city of St. Pölten can identify its vulnerabilities and improve its resilience over the next decade.

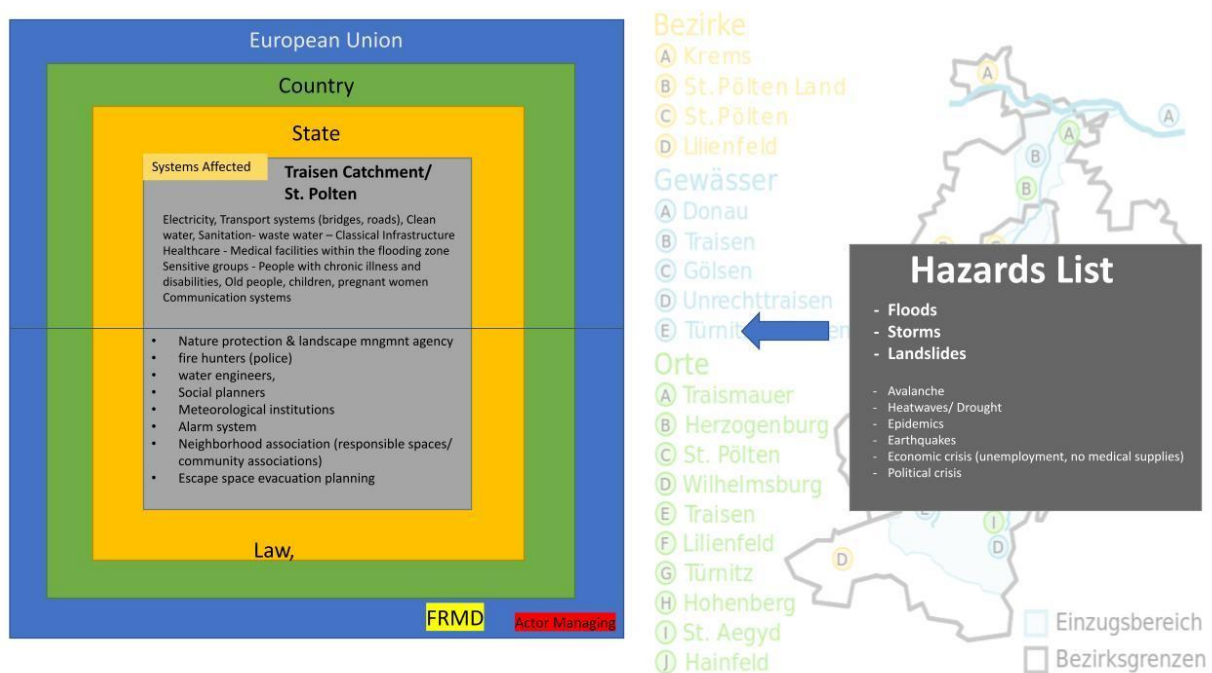


Figure 1: Pictorial representation of the system boundaries of this case. (Source: Authors)

1.1.3 Evaluation Criteria

Since the discussion revolved around improving resilience of St.Pölten in the events of disasters, the project team drafted an initial list of 6 evaluation criteria, namely; i) number of disaster related fatalities/morbidities in St.Pölten, ii) policy flexibility and resources available to healthcare infrastructure, iii) disasters/emergency response teams, iv) government responsiveness, v) economic stability and vi) ICT infrastructure development. These evaluation criteria would act as key indicators to measure the performance of St. Pölten and its capacity to be resilient to upcoming disastrous events like flooding in the next 10 years.

1.1.4 Impact Factors

The impact factors prepared for case 1 in St. Pölten were: i) the percentage of vulnerable population i.e. those who are children and senior citizens, ii) government budget levels allocated to administrative systems around disaster management, iii) healthcare infrastructure i.e. the number of healthcare workers and hospitals, iv) societal attitudes i.e. a measure to assess the trust levels of people in its government, v) information accessibility i.e. the different channels of information available to citizens to access key information in times of

crisis, vi) flood-related economic loss i.e. monetary approximations of economic value lost due to floods, vii) health literacy and self-help skills i.e. the abilities and skills of people to find, understand, evaluate, and apply health information to make appropriate health decisions in everyday life, viii) emergency care i.e. levels of appropriate intervention in times of emergency situations, e.g. set-up of emergency beds, ix) an adaptive and integrated crisis and risk management structure i.e. levels of vertical and horizontal networking across government unit hierarchies, utility uptime including ICT and electricity amidst flooding to effectively undertake associated emergency care and coordination, x) incidence of flood disaster-related mortality, and incidence of people affected by flood disasters i.e. the number of people affected through morbidities and/or economic loss borne by flood-related disasters.

1.1.5 Lessons Learned

Scholz and Steiner (2015) indicate key obstacles involved in the transdisciplinary process, some of which the project team encountered in the case of St. Pölten. From this reference, the team encountered a challenge relating to societal preparedness for a transdisciplinary discourse. First is an issue C1.5, of encountering challenges to achieve a balance between consensual and competitive modes, aiming to enable cooperative learning and motivation. Specifically, the key stakeholder in charge of managing disasters in St. Pölten did not see the value of undertaking a transdisciplinary process for the topic, as he mentioned that they already have a disaster management plan for flooding in place. While there was a communication exchange mentioning that the process seeks to bring scientists and practitioners together to further inform ways and means involving this endeavour, this was not received well. The second issue involves pre-competitive issues. In the process of inviting practitioner stakeholders, it was also determined that there was already a consulting firm engaged to tackle disaster management for St. Pölten. Given this, timings may not have aligned, and it would perhaps be more ideal if the transdisciplinary process was introduced to the government unit before they had organised the call for bids.

Taking these lessons into the implementation of case 2 involving the town of Langau, the team determined that it was critical to map warm contacts i.e. those that the project team have close connections to. This was streamlined by the team facilitator for case 2, who had local context and connections, given his lived experience in Austria. From the warm connections

available, two possibilities were outlined before pivoting to case 2: to either change the theme but work with the same community, or change community and work with the same theme. Given the available connections of the team facilitator, it was determined that changing the community would be more feasible. From here, conversations were initiated and the community of Langau, through its mayor, presented an opportunity to undertake the transdisciplinarity process, as there was a willingness from the practitioner stakeholders to undertake it.

1.2 Case 2: Langau

1.2.1 Characteristics of Langau

When talking about sustainable cities, the current status quo is that most of the literature focuses on the perspective of urban settings in terms of building resilient and sustainable cities (Homsy & Warner, 2013). Therefore, the effort here is to analyse the small rural communities and learn about their efforts towards being sustainable amidst complex global challenges, hence the idea of resilient sustainable Langau came into being.

The idea was first initiated by Professor Ilja Steffebauer due to Langau's unique geography and demographics. The town of Langau is located north of Waldviertel in Lower Austria in district Horn, sharing a border with the Czech Republic. The market community spans an area of 22.22 square kilometres, with the majority of the land (77%) being designated for agriculture and 15% consisting of forested areas (Wikipedia-Autoren, 2004). The town has had a population of around 700 people over the last 20 years, of which the majority of the demographics consists of the older population i.e. greater than 48 years.

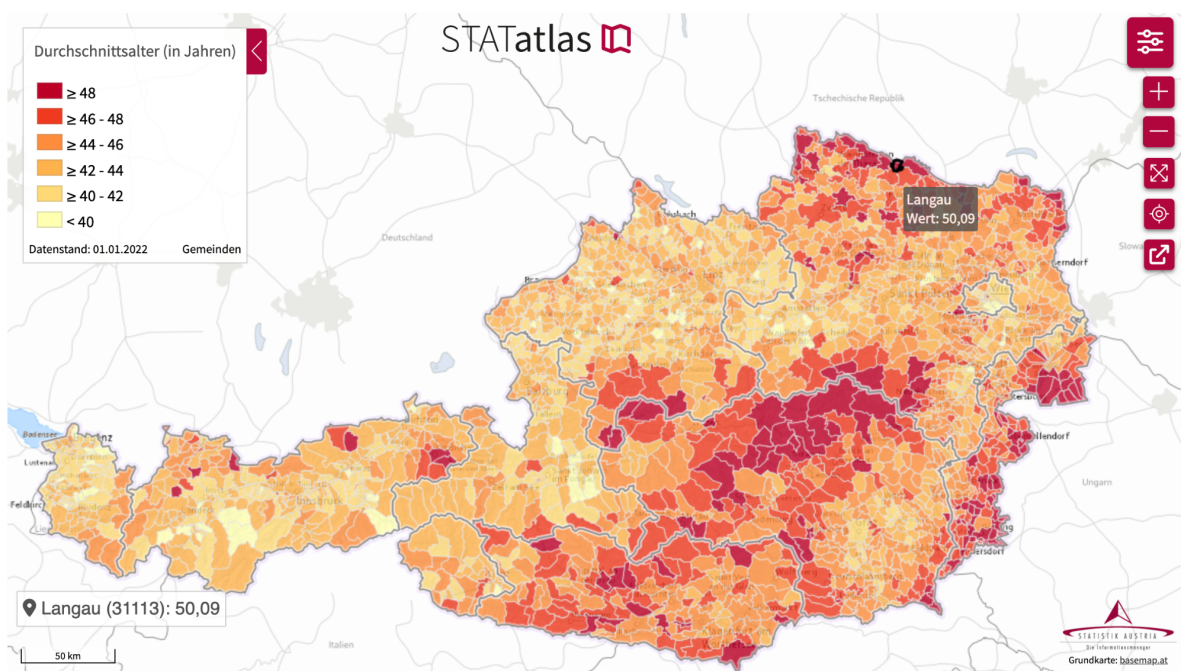


Figure 2: Graphical representation of average age across Austria. (Source: Statistics Austria)

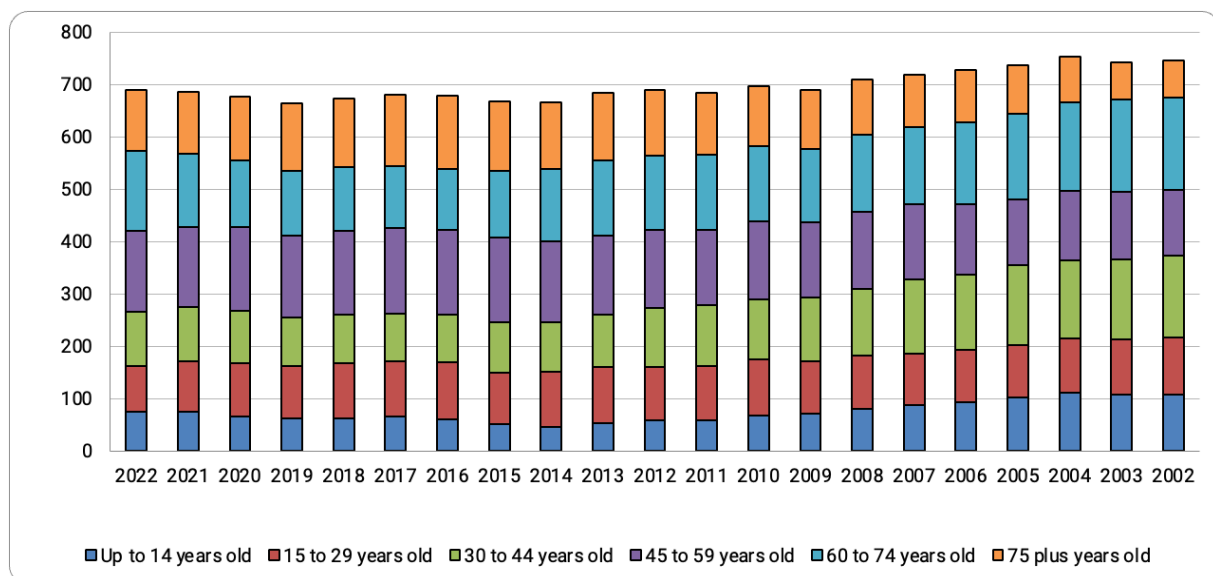


Figure 3: Langau population over 20 years across demographics. (Source: Authors' elaboration using data from Statistics Austria)

In figure 3, the interesting trend can be noted in green, purple, and blue bars highlighting age groups from 30-44, 45-69, and 60-74 years old. This age group can be seen as prominent in Langau, forming a substantial part of the population, which shows that Langau has an ageing population.

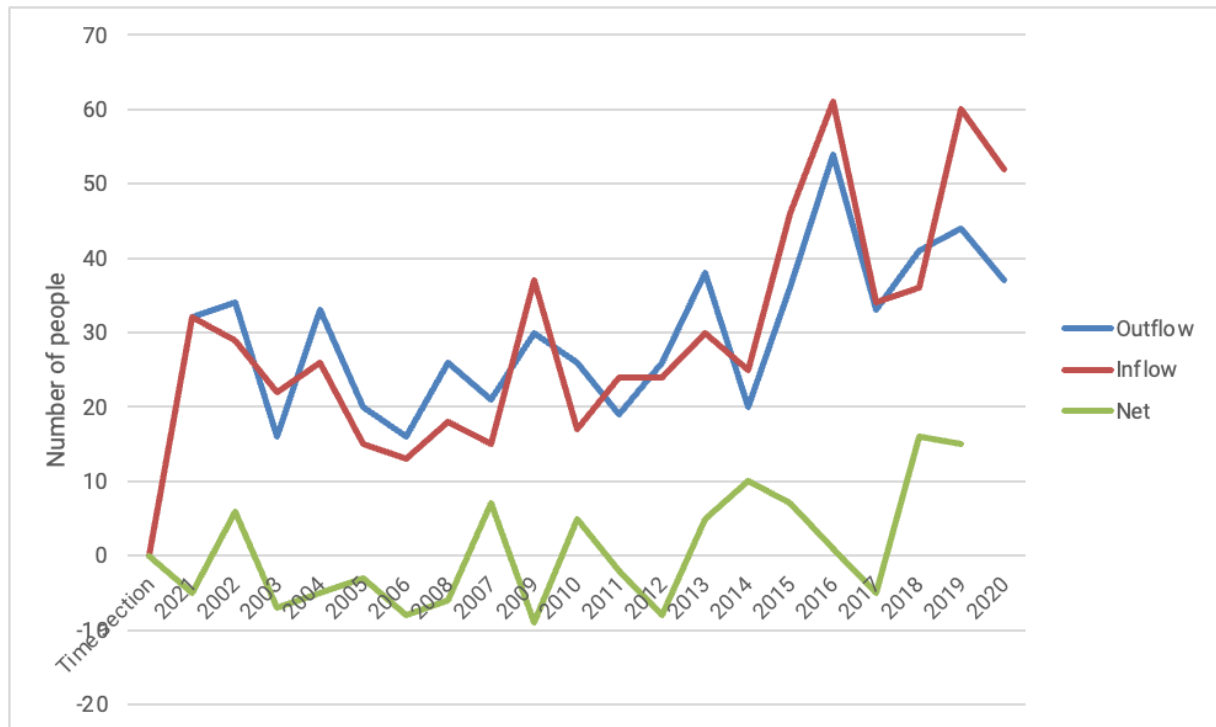


Figure 4: Net migration flow of Langau over 20 years.
(Source: authors' elaboration using data from Statistics Austria)

Furthermore, another interesting point to note is that there has been a consistent population inflow and outflow within Langau, hence being able to remain consistent in terms of its population size over the years.

The initial research also indicated that the community of Langau has a large number of civic and voluntary associations considering it is a small town. Some of them include the Red Cross, the Pensioners' Association, recreational/cultural groups (Music band, recreational climbing garden), and Sola-Eurosola. This shows that the community of Langau is close-knit which can be a force for sustainable community development (Homsy & Warner, 2013).

1.2.2 Guiding Question

The initial research on the town of Langau led to the formation of two versions of the first guiding question by the project team:

“How can the Social & Institutional Systems of Langau become resilient & sustainable amidst poly-crises in the next 10 years?”

And

“How can the Social & Institutional Systems of Langau become resilient & sustainable amidst poly-crises in the next 20 years, with the example of pandemics?”

This guiding question was created in March 2023 as an initial entry point into the system of Langau to establish the boundaries of the study. Social and institutional systems meant highlighting the institutions that are essential and need to be taken into consideration to make Langau resilient and sustainable. The premise behind using poly-crisis was to take into account a cluster of global risks which might have a compounding effect on the institutions and systems (Torkington, 2023). For instance, the pandemic here was taken through the lens of the global crisis which impacted global economies, and different institutions simultaneously.

The second version of the guiding question was then sent to the stakeholders via email for their feedback to learn from their expertise and improve the project team’s understanding of the needs of the community of Langau. Some of the stakeholders’ feedback regarding the guiding question are summarised in table 1.

Table 1: Stakeholders’ feedback on the initial version of the guiding question.

Stakeholders	Feedback on Guiding Question
Walter Hyll	• Since Langau is very small (regarding population size), systems probably need to be considered in a broader context i.e. what can Langau do, and what must others (e.g. at the district level) do.

	• I suppose Langau does not only face challenges regarding pandemics but health issues in general.
Tania Berger	• Is it that Langau is not resilient at all right now (as a status quo)? Or rather: shouldn't the discussion be about improving resilience?
Marina Knickel	• Maybe only making it more active would help, in a sense who is going to drive this process and create conditions? • Resilience seems central in the question, but I'm not sure how it's defined in the context of your project and for this community. • Was the Covid-19 pandemic so disruptive (economically, socially, environmentally?) for the community that it has become the main focus / main example of why Langau should become more resilient? • Suggested GQ: "How can actors within the Social & Institutional Systems of Langau contribute to making the community more resilient & sustainable amidst poly-crises in the next 20 years, learning from, for example, the Covid-19 pandemic?"
Christine Rottenbacher	• For me it is very important to identify a shared understanding of resilience, does it have to do with the flexibility of processes and the robustness of which systems? Is it possible to identify internal events, we cause ourselves and therefore can influence as a community? Is it helpful to differentiate internal and external events? Why? • What are the "ingredients" that a community needs for a good life at a "healthy" place to strengthen and maintain its resilience?
Andrea Holtl	• It could be interesting, which of the (potential) crises the region is aware of and how they see the links between the crises. And, how they could develop strategies for adaptation, considering synergies and trade-offs between different measures and goals (maybe along the SDGs). And behind the question, what does a resilient & sustainable system mean for the people in the region?

Keeping this feedback in mind, the project team conducted the first stakeholder conference which gave further insights into the community of Langau regarding their challenges and

areas they feel need to be improved further. Some of the key points from the conference which lead to the improvement of the GQ were as follows;

- The pandemic was not a huge disruption for the community due to its strong network of associations and volunteer groups, which is their strength.
- Langau is politically and socially homogeneous. However, 20 years ago, the community was quite divided into political lines and this homogeneity is the result of intense work by community leaders during the last 20 years.
- They do not consider the ageing population as a challenge but rather a strength for them, young families with children are moving back to Langau. Hence, intergenerational living is quite good.
- The community has a strong sense of “We” among themselves which they take pride in. The community spirit for them is the essence of being a more sustainable community.
- More than resilience (in terms of bouncing back), they are focused on long-term and sustainable practices related to socio-environmental aspects.

The feedback from the scientists and practitioners resulted in the development of a new and **final GQ** which was presented as follows;

“How can the community actors of Langau improve the adaptive capacity of its social infrastructure for the next 20 years?”

The discussion during the first stakeholder conference revolved around the sense of community and using that to tackle sustainability challenges lead us to the creation of this version of GQ. The focus was more on social cohesion, leading to the well-being aspect of their social infrastructure.

2 System Analysis

2. 1. Elements of the system

Considering the system, Langau in this case, it was identified, through research and inputs from stakeholders, that there are some elements which are central to this system and have a strong inter-relation to other factors. These have been identified in the guiding question.

Given the current status of Langau, community actors play a vital role here. Marsden (2005) states that units in society that compose networks are often individuals but networks also comprise other units such as families, associations, organisations including formally instituted groups such as schools and workplaces. These can be considered as community actors that have a diverse relationship among each other, including interdependence, communication, membership, solidarity and affect. Drawing from Marsden's work on Network Analysis (2005), it can be understood how community actors form social networks that are key constituents of concepts of social capital. Marsden states that these actors can gain an advantage by making use of resources, information and opportunities available through social ties and their standing within the community. Such capital can amplify individual and community capacities, and the support flowing through the networks created by these actors can improve well-being among individuals and units in the system, as well as buffer the effect of risks and stressors.

Different institutions and units in Langau have been identified as community actors that play an influential role:

- **Municipal Office:** Apart from being the key political and administrative stakeholder for this town, it is responsible for various facilities and spaces including the nursery, elementary school, leisure hall, etc.
- **SOLA-EuroSOLA:** Runs a number of camp facilities and accommodation in Langau and neighbouring regions, located directly at the Langau leisure lake and offers children adventurous days in nature with a capacity to accommodate 40 people (*Marktgemeinde Langau*, n.d.).

- **Volunteer firefighter:** With 4 vehicles, the FF Langau is very well equipped in terms of motorization and to avert danger to people, animals and essential goods (*Marktgemeinde Langau*, n.d.).
- **Recreation/Cultural Groups:** The Music band of Langau, founded in 1956, has active musicians and organises a spring concert. Music Without Borders is another association with active members from Austria as well as the neighbouring Czech Republic. The town also has sports clubs, a museum association and an amateur play association. The Carnival Guild Langau, founded in 2002, attracts around 1500 guests every year for its main event and has over 60 members (*Marktgemeinde Langau*, n.d.).
- **Parish Church:** The Church of Assumption of Virgin Mary, located in the town centre has women's and men's movement and does education work, attempting to engage with the community. It also has an active choral society and choir group (*Marktgemeinde Langau*, n.d.).
- **Seniors and Pensioners:** Lower Austria Seniors: This association represents the interests of pensioners along with the Pensioner's Associations SPÖ (*Marktgemeinde Langau*, n.d., Stakeholder Conference).
- **Community Nursing:** Started in 2022, this pilot project works on health intervention, including preventative measures and also awareness. It aims to enhance the capacity of the citizens to manage their illnesses and health (Stakeholder Conference).

Other community actors that also play a crucial role in this town are local businesses, farmer's associations, establishments and waste management.

The community actors function within the social infrastructure of the system, i.e. Langau. Social infrastructure comprises networks, services, facilities and spaces by government, non-government and other service providers that support the well-being and quality of life within a community. These are places that allow people to gather, experience culture together and comfortably live alongside one another (Latham & Layton, 2022). Through their function of providing services to people, they are spaces of sociality that are essential in supporting the liveability of a town or a city. The Australian Government (2020) states that these services

together build a network of social infrastructure which contributes to social identity, inclusion and cohesion.

With the help of a strengthened social infrastructure, the adaptive capacity of a rural area, town or city can be enhanced and even augmented. Adaptive capacity ‘comprises the properties of a system that enable it to modify itself in order to maintain or achieve a desired state in the face of perceived or actual stress’ (Jakku & Lynam, 2010). Strengthening the adaptive capacity of a system can make institutions, systems and individuals to adjust to any harm, utilise opportunities and cope with the consequences. Jakku and Lynam also emphasise that in a broad sense adaptive capacity is context-specific, dependent on access to resources, shaped by interdependent factors and goes beyond the coping ability. Although similar to the concept of resilience, adaptive capacity is more narrowly focused on the specific skills and mechanisms that are deployed by human systems to contribute to resilience (InTeGrate, n.d.).

2.2 Framework to comprehend the status quo of Langau

With a clear perception of the key elements in Langau, the Rural Wellbeing Framework developed for the Centre for Thriving Places (see figure 5) provides further understanding of the systemic analysis of this town. This framework is designed to summarise the key drivers and conditions for rural wellbeing (Muller et al., 2021). The report focuses on the narrower definitions of personal and community well-being in order to gain further ‘clarity into the key drivers of rural wellbeing, the local conditions and contexts that most influence individual and community wellbeing, as distinct from wellbeing itself.’ Personal well-being in the report, is defined as ‘how satisfied we are with our lives, our sense that what we do in life is worthwhile, our day to day emotional experiences (happiness and anxiety) and our wider mental wellbeing’.

The key domains identified in this framework are:

1. **Economic Opportunities** wherein apart from the economy, the domain includes factors around education opportunities, financial security, rural poverty, and seasonal impacts on jobs and housing.
2. **Community** which reflects both a geographic and social community, combining social capital, sense of belonging, participation and power.

3. **Environment with proximity to nature** is a key driver in rural wellbeing, but also encompassing culture and heritage, as well as the built environment and safety.
4. **Health** in physical and mental terms are key drivers of personal wellbeing in rural areas (no different to nonrural locations).

Alongside these domains, well-being is viewed through the wider lenses of:

1. **Access** which plays a key role in rural areas to enable wellbeing. It needs to be considered both in terms of access to other domains of the framework (services, jobs, support etc) and access via key enablers (transport, digital etc).
2. **Equality** – also referred to as fairness or inclusiveness – is another key enabler. Life stages, capabilities and characteristics all play a role in whether a person might or might not have equal access to what enables their wellbeing.

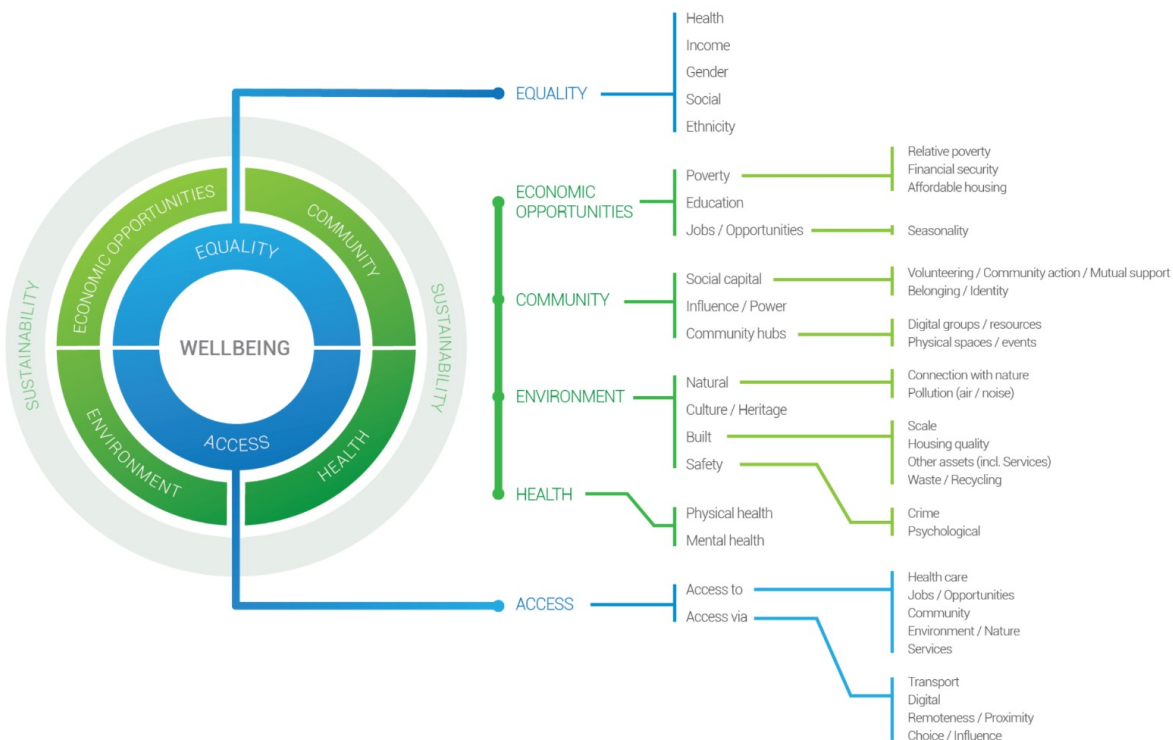


Figure 5: Rural Well-being Framework. (Source: Centre for Thriving Places)

Langau, for a town of its population and size, has a considerable number of associations and organisations, which gives opportunities for the community to come together and forms part

of its social infrastructure. During the conduct of the first Stakeholders Conference, the practitioners and community members of Langau have identified the ‘community spirit’ and a ‘sense of we’ as being the essence and strength of the people living here. Thus the challenges that Langau faces in each domain of the framework can be viewed through the lens of this ‘community spirit’ and how it can contribute to addressing the challenges. As stated in the report of the Rural Well-being framework:

As the model Theory of Change for Community Wellbeing shows, in addition to the things that drive individual wellbeing, when we think about the collective of a community there is evidence to show that how individuals relate to each other within their community and the level of influence that they have over decisions for their community also influences collective wellbeing (Muller et al., 2021, p. 12).

Social identity and cohesion, which refers to the strength of relationships and a sense of solidarity among community members (Kawachi & Berkman, 2014), is identified as a vital characteristic of Langau. However, the community members and stakeholders have also identified the lack of physical spaces and meeting points for the community to gather as a barrier. So though the greater social cohesion of the town is an asset, without spaces to enhance it can cause a hurdle in amplifying the collective well-being of the town as also addressing its challenges.

2.3 System model of Langau

As Langau is a town that is situated on the border of Austria to Czech Republic, it is important to comprehend the system in terms of geographic understanding based on the region and the state that it is located in. Its neighbouring towns, both in Austria and the Czech Republic, are a part of the regional ties that Langau builds. The socioeconomic, political and legal factors and developments in Lower Austria, Austria and the EU also impact the town.

Within Langau, different domains form an interrelation and interdependence to impact the life of the people in Langau. The stakeholders, scientists and practitioners have contributed to understanding the status quo of these domains.

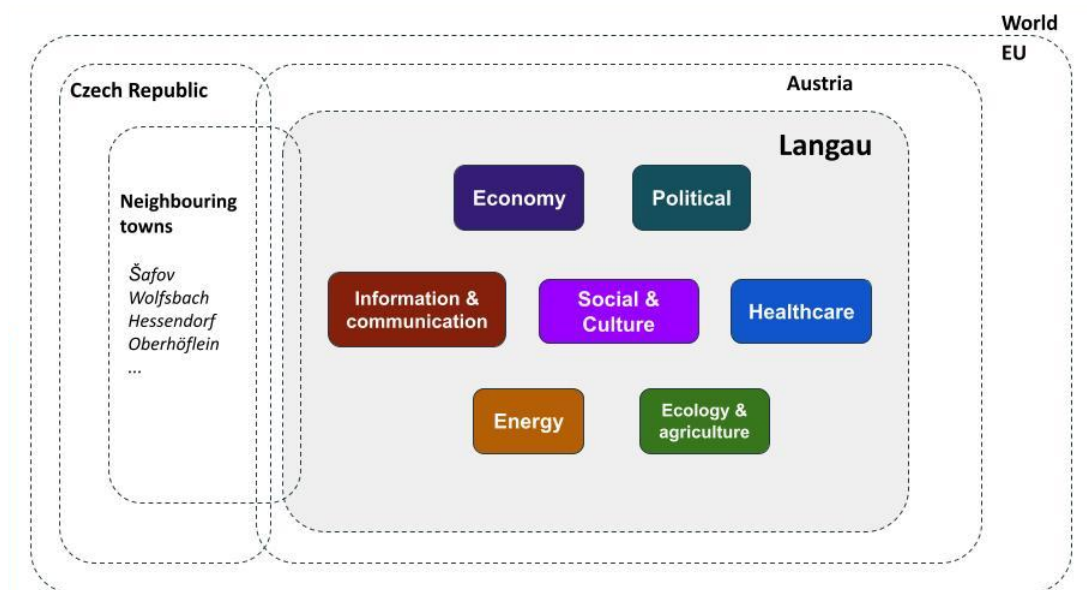


Figure 6: Visual representation of the system model for Langau. (Source: Authors)

2.3.1 Economy

40 years ago, the need to migrate from this town for better opportunities was greater, stated by the incoming mayor, Daniel Mayerhofer during the stakeholder conference. With the ushering in of the internet and better infrastructure, this situation has changed. More people have created businesses here. However, there is still a lack of economic activity, in terms of providing jobs for everyone. This is why people here are involved in more than one occupation and commute to neighbouring towns and regions for work.

2.3.2 Political scenario

The municipal office, headed by the mayor, is in charge of the administration of community affairs and services, including basic utilities and facilities. Langau is politically homogeneous. However, 20 years ago, the community was quite divided on political lines and this homogeneity is the result of intense work by community leaders during the last 20 years.

2.3.3 Information and Communication

The town's municipal office is responsible for dispersing information and maintaining communication channels on critical issues in the town. The numerous associations and

organisations also create their network of information sharing. As experienced during the team's 3-day stay in Langau for the purpose of conducting the stakeholder conference, internet infrastructure is stable in this town, linking it to the larger systems outside.

2.3.4 Energy

In Langau, 136 houses have heating by the central plant since 2001 as stated during the stakeholder conference. This reduces their dependence on the national grid. In terms of renewable energy, solar photovoltaic systems are unavailable. The community identifies energy transition and autonomy as a long term challenge. The town has Erneuerbare-Energie-Gemeinschaft, a renewable energy association that is working towards supplying energy through renewable sources as a possibility for its citizens (Mayerhofer, n.d.).

2.3.5 Healthcare

The community nursing project is key to addressing the health needs of the population of Langau, which is largely ageing. 24/7 health services for the elderly as also for other groups of the population like children, youth and women is a challenge here. The community nursing project is trying to address this problem by focusing on preventative medicine as also health literacy. The project aims to enhance the capacity of the citizens to manage their illnesses and health in their homes for as long as possible. The work of the project goes beyond nursing and includes getting state subsidies for patients, forming a network of support for the patients, advising and guiding them on where to get the help they need. For secondary healthcare, the residents of the town need to go to facilities in neighbouring towns around half an hour away, as shared during the stakeholder conference.

2.3.6 Social and culture

The numerous associations and organisations, (Section 2.1) are important for the community to facilitate interaction, cohesion and provide services. The events organised by these groups also serve as a reason for people who migrated from the town to cities for different purposes to come back and participate, as shared in the stakeholder conference by Martina, member of the carnival guild of Langau. Apart from identifying the community spirit as a strength of the

town, the stakeholders also state that learning and working together through debate and dissent is important.

2.3.7 Ecology and Agriculture

The involvement of the people in agriculture is due to land that has been acquired through inheritance and passed down through generations. Farming in Langau works as supplementary income and not just primary or direct income. The community is resisting industrialisation of agriculture and focusing on small-scale farming. However the community identifies their challenge to introduce better cropping patterns and chiefly make the agricultural landscape more resilient, especially to soil erosion caused by high wind velocity. Another issue is the management of water, especially potable water, due to high iron content in Langau's immediate water sources, as well as deforestation, droughts and bug infestation that can potentially destroy plantations. The concern of the people is more focused on “how much autonomy we have achieved” than “how much we produce or have” and it highlights the awareness that the people of the town have in terms of managing the climate crisis.

Hence, in the context of Langau, it is imperative to understand the interconnections among these domains creating dependencies and also effects on each other, which is what this report aims to do. This will help in analysing and comprehending the full picture of the status quo of Langau and take us closer to answering the guiding question in a rigorous manner.

3. Methodology

Following a Transdisciplinarity process (Scholz & Steiner, 2015a), a vulnerability analysis of the community of Langau has been conducted using expert-based scenario construction and assessment based on the SVIDT method explained in Scholz (2017). Using multi-criteria assessment (MCA), the potential losses from three threat scenarios is evaluated for Langau to calculate the Risk score. Intervention scenarios are constructed to mitigate the performance loss due to the threats. MCA is applied again to evaluate the performance loss reduction after the intervention scenarios and used to calculate the Adaptive Capacity score. The Risk and Adaptive Capacity scores form the basis to calculate the vulnerability of the community of Langau in face of challenges in the next 20 years.

3.1 Transdisciplinarity Process

Transdisciplinarity is a method to relate and integrate the knowledge and epistemics from different scientific disciplines and stakeholder groups (see the Brunswik lens model of knowledge integration in figure 8) to solve complex societal problems that can't be dealt with disciplinary knowledge and expertise. In a transdisciplinarity process, a selection of experts of science and practice participate in a number of meetings (a.k.a. Stakeholders conference) conducted by “Transdisciplinarity facilitators” and they might also be asked to provide feedback before and after the meetings (Scholz & Steiner, 2015b). The ideal outcome of a transdisciplinarity process are Socially Robust Orientations (SoROs) that are scientifically sound and socially accepted. These orientations provide options of solutions for sustainable transitioning of complex real-world problems. (Scholz & Steiner, 2015a)

In this TFRT, a condensed form of a Transdisciplinarity process was conducted. The process can be characterised by conducting only one stakeholder conference and the SVIDT evaluations being only from the facilitators. The project was conducted in 4 phases as described in the following subsections.

3.1.1 Initiation Phase

3.1.1.1 Preparatory training

During summer and autumn 2022, the facilitators participated in an initial teaching course on the methodology and application of the Transdisciplinary field research process. Relevant papers, case studies and lectures provided by the Transdisciplinary Field Research Training (TRFT) team were the main pedagogic material in this phase. This phase was concluded with an exam which evaluated the facilitators' theory knowledge on transdisciplinarity, its processes and methods.

During winter 2022, the facilitators formed their team and participated in a two-day intensive workshop on approaching guiding questions, system boundaries and stakeholder analysis. During and after the workshop, literature research and background study of the case 1 of the project (Resilient Healthy Cities: St. Pölten) was conducted and an initial list of potential stakeholders were identified with the support from Professor Heike Köckler (former facilitator for St. Pölten case). However, due to several reasons (which has been explained in section 1.1), the team moved forward by shifting the focus of the case study from St. Pölten to Langau, a rural town in Lower Austria bordering the Czech Republic.

3.1.1.2 Development of The Initial Guiding Question and System Model

To start the Transdisciplinarity discussion with the stakeholders, an initial problem statement in the form of a 'guiding question', and an understanding of the system under consideration, in the form of a 'system model' is necessary. Therefore, the facilitators developed the first version of the guiding question based on the background study on Langau, Austria, and the state of the art rural development discourse. System model and system boundaries were also defined as mentioned in section 1.2.2 of this report.

Guiding Question - Version 1

“How can the Social & Institutional Systems of Langau become resilient & sustainable amidst poly-crises in the next 20 years, with the example of pandemics”

3.1.1.3 Identifying and Contacting Stakeholders

With the support from Dr. Ilja Steffelbauer and Dr. Christine Rottenbacher, the stakeholder list of practitioners and scientists were identified and contacted. A first letter of introduction and invitation for the first stakeholder conference in Langau was sent followingly for the stakeholders from the domains of science and practice.

3.1.2 Preparation Phase

The preparation phase consisted of constructing the initial version of the SVIDT variables to consult with the experts and receive their initial feedback prior to the stakeholder conference. During the preparation phase, 6 potential Impact Factors and 6 potential Evaluation Criterias were constructed by the facilitators. The details are discussed in section 3.2 of this report.

Stakeholders who had accepted the invitation call were followed up with the feedback form/working sheet where they can fill out their feedback and suggestions on the proposed guiding question, initial impact factors and evaluation criterias. This initial feedback process set the ground for an epistemological knowledge integration in the first stakeholder conference. A summary of the feedback in this part is provided in section 3.2 of this report.

3.1.3 [First] Stakeholder Conference

The planning for the first stakeholder conference was composed of stakeholder appointments, logistics to accommodate stakeholders, facilitators' travel and accommodation, consolidation of scientists' (experts in this case) feedback, preparation of agenda and presentation/discussion for stakeholder conference.

The first stakeholder conference was held in two parts, in the morning and afternoon of Tuesday, March 28th, 2023. Six scientists from different scientific disciplines and 8 practitioners from different stakeholder groups in total participated in the conference. A full

list of the scientists and practitioners, along with their profiles can be seen in figure 7. This figure shows how experts from science and practice come together in a Transdisciplinarity process and the knowledge integration takes place to form socially robust orientations for complex societal problems (resilience and sustainability of Langau in this case). The discussions and exchange of ideas in the first stakeholder conference, facilitated by the TD facilitators, allowed for an epistemological knowledge integration to take place.

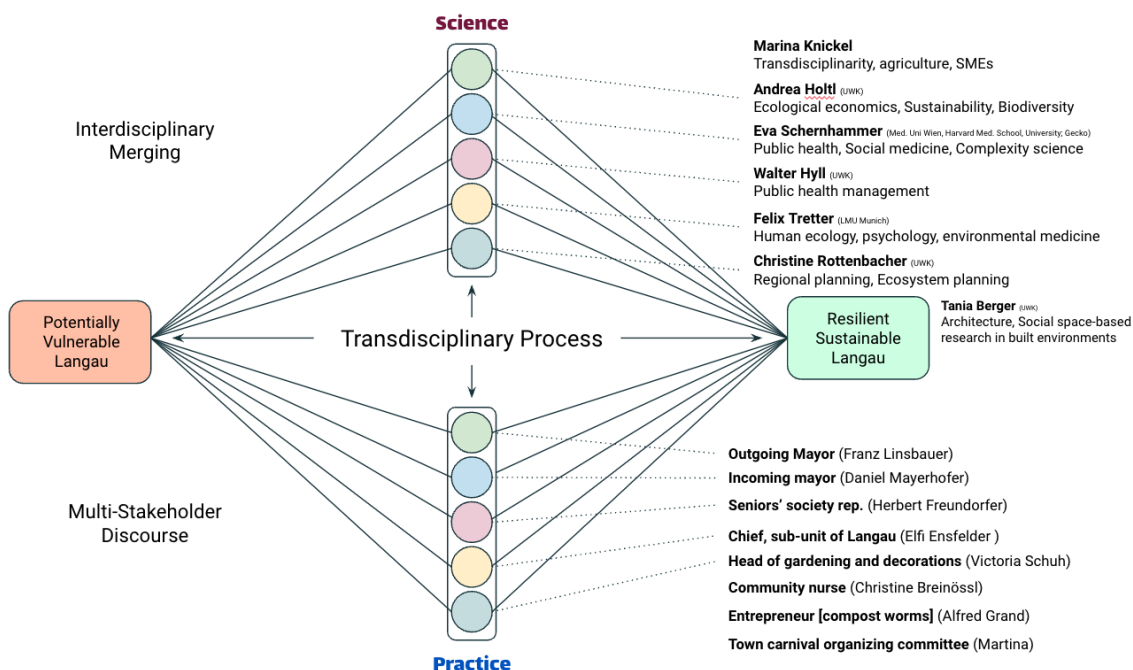


Figure 7: The Brunswik lens model of knowledge integration in this Transdisciplinary project.
The model includes the names and profiles of the stakeholders. (Source: Authors)

3.1.4 Analysis and Reporting

After the synthesis of insights and feedback from the first stakeholder conference, a new guiding question, a new set of impact variables (IFs) and evaluation criteria were constructed as described in details in section 3.2 of the report.

Guiding Question - Version 2 (Final)

“How can the community actors of Langau improve the adaptive capacity of its social infrastructure for the next 20 years?”

The revised impact factors were used to conduct a formative scenario analysis (FSA) using the SVIDT method. A summary of the scenario design process conducted in this study can be seen in figure 8. The details of the SVIDT method implementation are discussed in the following section.

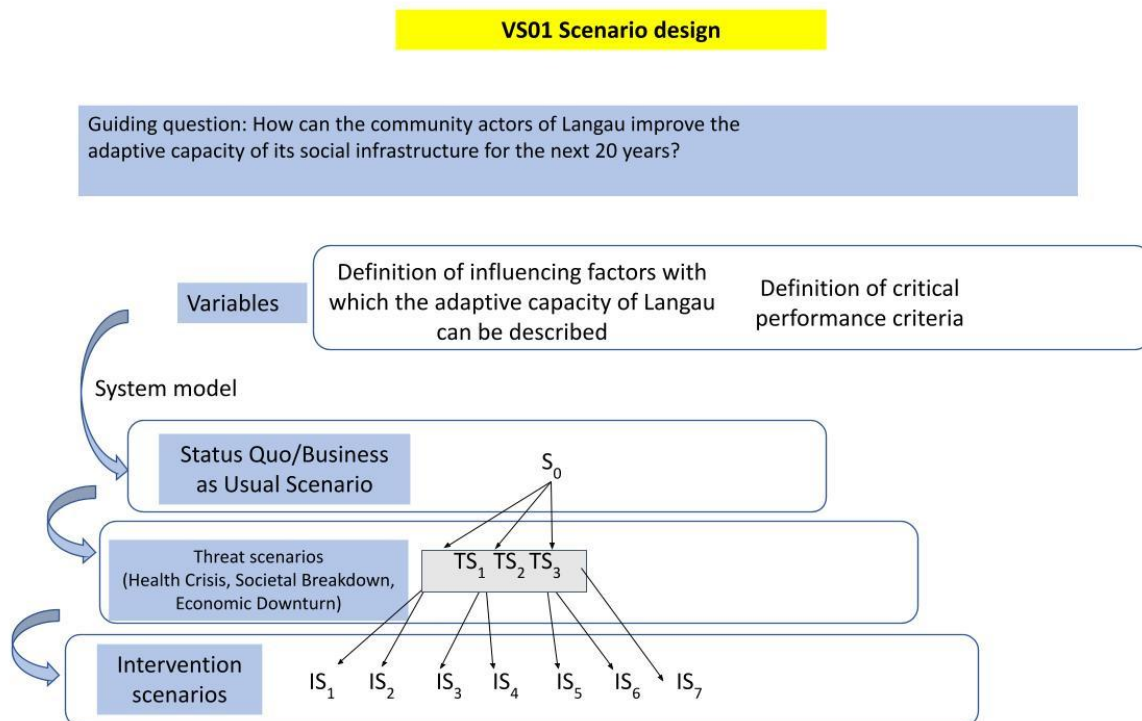


Figure 8: Scenario Design of VS01 Transdisciplinary Process

The final report of this TFRT was constructed with equal contribution from the facilitators after application of the FSA and SVIDT methods. After the unsuccessful launch of the first case (St. Pölten) and delay in the timeline, the second stakeholder conference is yet to be discussed whether to be held or replaced by a written report and follow-up evaluations from the stakeholders.

3.2 SVIDT Method

The Strengths, Vulnerability, and Intervention Assessment related to Digital Threats (SVIDT) method is a management tool to systematically identify and assess the vulnerabilities of human systems with respect to digital threats and changes (Scholz, 2017). The main steps of the SVIDT method can be seen in figure 9.

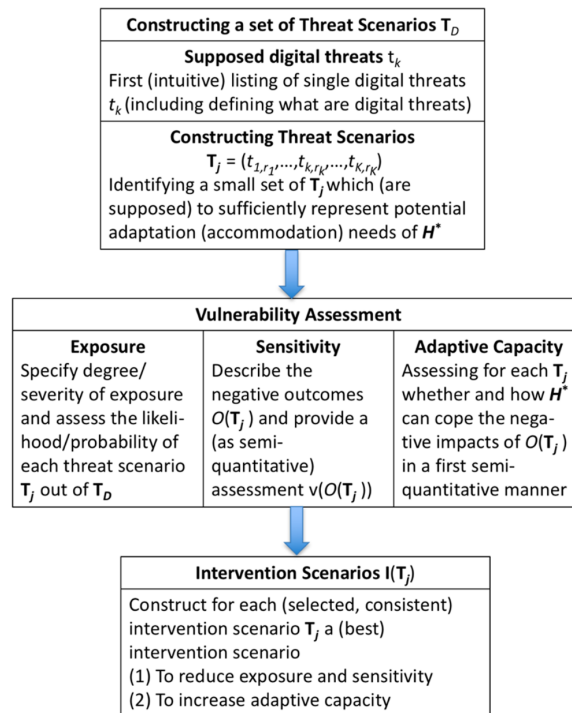


Figure 9: Main steps of the SVIDT method. (Source: Scholz, 2017)

3.2.1 Impact Variables

Impact variables (a.k.a impact factors) describe components that fundamentally influence or are influenced by system behaviour and its parameters (Lang, et al, 2006). Impact Variables are used in the risk assessment process to construct threat scenarios. To that goal, on top of the choice and definition of the threat variables, it is necessary to define the states of “status quo”, “high”, and “low” for each of them. In this case, low describes the situation where the threat has not occurred, and high describes the case where the threat occurs.

3.2.1.1 Initial Impact Factors

The initial lens for the guiding question for the town of Langau involved resilience and sustainability in the context of pandemics. This was revised to a 20-year time frame in order to accommodate longer-term perspectives.

As part of the preparations for the 1st Stakeholders conference, impact factors (table 1) were prepared alongside the guiding question, system design, and evaluation criteria. Impact factor names and definitions were sent over electronic mail to invite experts for feedback. Thresholds and references for suggested measures were also prepared in this version but were not shared for feedback, so as to allow for other ideas from the experts that can capture the labels in a more relevant way.

Table 2: Initial Impact Factors prepared by the team prior to the Stakeholder Conference.

#	Label	Definition & Reference	Status Quo	Low	High
1	Vulnerable population	Number of people above 65 years, people with disabilities, pregnant, children below 15, and people with chronic illnesses	19.36% of population Proportion of elderly population for Austria (OECD, 2021)	<19.36%	>19.36%
2	Healthcare system	Number of healthcare workers per 100 people	1.6 workers per 100 people Austria: 1614.4 healthcare workers per 100,000 inhabitants (Eurostat, 2020)	<1.6	>1.6
3	Civic support and voluntary organisations	Number of volunteers in the community	36.7% of population (informal) 25.8% of population (formal)	<36.7 % <25.8 %	>36.7 % >25.8 %

			Volunteerism levels for the whole of Austria (Statistik Austria, 2022)		
4	Neighbouring affiliations	Frequency of contact with organisations in the neighbouring town; proxy measure via number of formal agreements undertaken involving neighbouring towns	“100” “100” serves as baseline value, based on the number of collaborations w/ neighbouring towns for disaster response	<=80	>=120
5	Utilities infrastructure	Number of people experiencing disruptions in water, electricity, garbage, ICT utilities during disasters	95% uptime levels Assumed figure, based on incidence of energy supply shortages from climate change impacts (CGTN, 2022)	<95%	>95%
6	Economic productivity	Percentage of working age population with an occupation	73.9% Data for whole of Austria in Q4 2022 (OECD, 2022)	<73.9%	>73.9%

From here, a brief on the project was sent to science experts in the fields of complexity science, public health, human ecology, regional planning, and ecosystem services. Table 2 summarises the feedback insights received from five experts prior to the conference.

Table 3: Expert Feedback summary from the initial set of Impact Factors presented.

Impact Factor	Expert Feedback Insight
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Vulnerable population	● Consider including the lens of agriculture stakeholders, businesses and government entities ● Consider Economy for the Common Good framework: human dignity, solidarity & social justice, environmental sustainability, transparency and co-determination ● Consider prevention measures for a healthy life ● Consider permanent care that responds to climate change i.e. extreme heat
Healthcare system	● Consider health needs of the community, i.e. doctors and specialists ● Consider lifestyle norms e.g. ability to have breaks, rest, recover
Civic support and voluntary organisations	● Consider focus on relevant organisations ● Assuming incidence of out-migration; consider interest to attract foreign in-migration
Neighbouring affiliations	● Consider accessibility between neighbourhoods ● Consider village renewal efforts ● Consider both internal and external contacts
Utilities infrastructure	● Consider community perceptions of blackouts and desire for a more lively community ● Consider preparation mechanisms for blackouts
Economic productivity	● Consider when citizens feel productive ● Consider subsistence incidence in the community ● Consider effects of mobility cost increase associated with commutes to work and/or school ● Check unemployment rate, part-time / full-time employment, voluntary employment (men and women)

A significant amount of the points mentioned in writing were also brought up in the discussions at the first stakeholders conference. From these insights, the team revisited the impact factors to align them towards the predominant stakeholder sentiment and prioritisation on care, strengthening the element of “we”, as well as achieving sustainability in a multi-faceted approach. The revised and second set of impact factors, outlined in Table 3,

seeks to capture elements concerning social cohesion both within the town and across neighbouring towns, as well as sustainability in terms of economic sustainability and its related inputs i.e. people, natural resources, and business activity.

3.2.1.2 Revised Impact Factors

In table 4, an explanation of the variables considered in preparation for the threat scenarios can be seen as follows.

Table 4: Revised Impact Factors based on Expert Inputs from the Stakeholders Conference.

#	Impact Factor	Definition	Status Quo	Low	High
d_1	Population flow	Net migration i.e. the number of immigrants less number of emigrants (The World Bank, n.d)	16 people 2019-2021 average (Office of the Lower Austrian State Government, n.d)	<16	>16
d_2	Dependency on institutional care	Average number of days of inpatient stays in acute hospitals	6.3 days Average number of days for the whole of Austria, 2021 data (Statistics Austria, n.d.)	<6 days	>6 days
d_3	Civic engagement	No. of community members who are active members of a voluntary association/project	24% of population (171 members) Langau club membership count, where available (Municipal Office Langau, n.d.)	<=20%	>=30%
		No. of projects/initiatives in the town	“100” “100” serves as baseline value, based on existing number of projects	<=80	>=120

d_4	Regional Cooperation	No. of collaborative projects and initiatives with neighbouring towns and within regions	“100”	≤ 80	≥ 120
		No. of resource-sharing agreements with neighbouring towns and within regions	“100” “100” serves as baseline value, based on existing number of projects	≤ 80	≥ 120
d_5	Environmental factors of agriculture	Soil health	3% humus content in soil Baseline sampling showing humus levels across regions in Austria, within the 3% range (AGES, n.d.)	$\leq 2\%$	$\geq 4\%$
		Renewable Energy use	“100” “100” serves as a baseline value, based on the existing number of members within the renewable energy grid, primarily via photovoltaic sources as of this writing (Energie Zukunft Niederösterreich. (n.d.))	≤ 80	≥ 120
d_6	Ease of doing business	No. of new businesses established in a year	5 48 businesses in current directory; assume 10% growth (Municipal office Langau, n.d.)	≤ 3	≥ 7
d_7	Economic Activity	No. of people engaged in full employment, part time employment, subsistence activity	140 people employed 2011 data for Langau, currently not	≤ 120	≥ 160

			disaggregated by employment type (Statistik Austria, n.d., and Office of the Lower Austrian State Government, n.d.)		
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Population flow (d_1) tracks population levels as a precedent to activities around social cohesion, cooperation and economic productivity. Dependency on institutional care (d_2) seeks to measure availability and uptake of institutional care, but also as a proxy for assessing the impacts of community care efforts like the community nursing project to deter further escalation of health cases into secondary institutional care. Civic engagement (d_3) measures the extent of engagement that community members have towards community projects within Langau, as identified through organisational memberships and number of projects undertaken. Regional cooperation (d_4) seeks to track the extent of collaboration that Langau engages in around its neighbouring towns, and/or collaborations done on a district and/or regional level. For example, a municipal tractor was purchased in cooperation with the market town of Weitersfeld in 2010 (Linsbauer, F., n.d.). It was also mentioned in the stakeholders conference that Langau currently sources its water from a neighbouring town, as its internal water source contains high levels of iron, unfit for human consumption. For assigned values, it is worth noting in both impact factors d_3 and d_4 that a value of “100” is set as baseline for quantitative measures that are unknown, with high and low scores set to capture variances from status quo accordingly. For environmental factors of agriculture, soil health scores and community member participation in renewable energy efforts were chosen as measures. The latter serves as a proxy for household use of renewable energy given first-hand insight learned in the stakeholder conference of how farming activities in Langau are categorised as non-industrial, and are instead considered to be lifestyle-based. Other further measures for d_5 could be robustness of its irrigation systems as well as crop rotation practices, but are excluded for purposes of due scope of this study. Ease of doing business (d_6) is measured by the number of new businesses in Langau, assuming 10% annual growth of base number of businesses as the status quo. Finally, economic activity (d_7) is measured by employment levels. In this study,

the metric currently captures full employment based on available data, but can be further fine-tuned by disaggregating between employment types, e.g. part-time employment, and further specified into hours of work and work-life balance practice assessments of work opportunities in Langau, where data is made available.

3.2.1.3 Impact Variables into Scenario Analysis

These impact factors were then assessed as input into the scenario analysis process. The team assigned scores between correlations of factors, and then proceeded to do a consistency analysis by assigning scores associated with possibilism of co-occurrences between factors in both its low states and high states. From here, the system graph and system grids are generated. Figure 10 shows the system graph, with red nodes representing impact factors that impact other factors more than they are impacted (civic engagement, regional cooperation and environmental factors of agriculture) whereas red nodes represent those that are more impacted by other factors rather than making an impact on those other factors (population flow, dependency on institutional care, ease of doing business and economic activity). The two digits below each node represent interactions between variables i.e. the second digit represents the number of factors that the variable affects, whereas the second digit represents the number of factors that the variable is affected by.

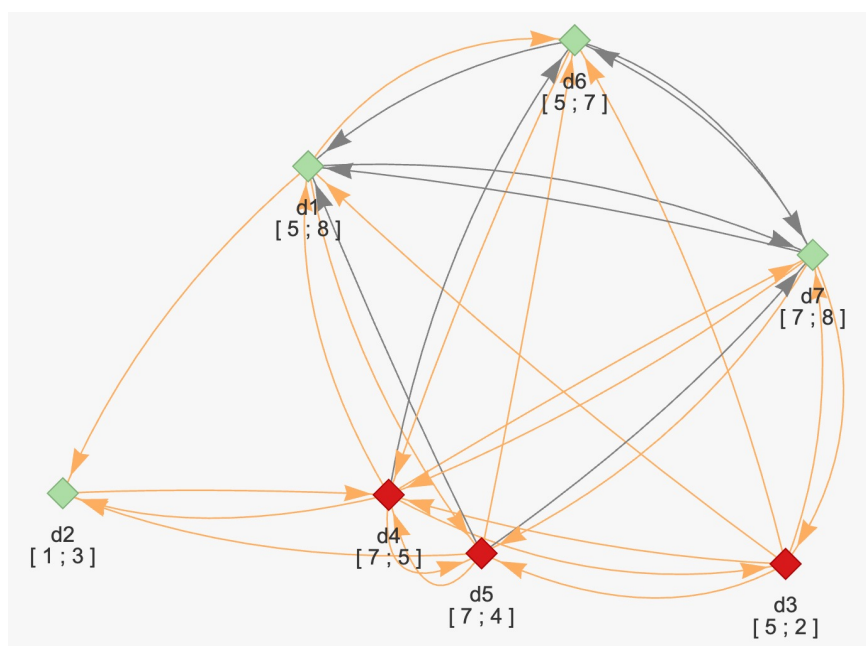


Figure 10: System Graph for VS01 Impact Factors. (Source: Authors)

Figure 11 is a system grid presenting an alternative visual of the factors, based on the degree of activity, sensitivity or passivity. Activity pertains to the no. of linkages, whereas sensitivity is the degree to which a factor is affected by other factors. It can be seen that most factors are active, with the nodes in green being more sensitive. It shows that the green nodes are less sensitive to other factors making it affect other factors more than it is affected by them.

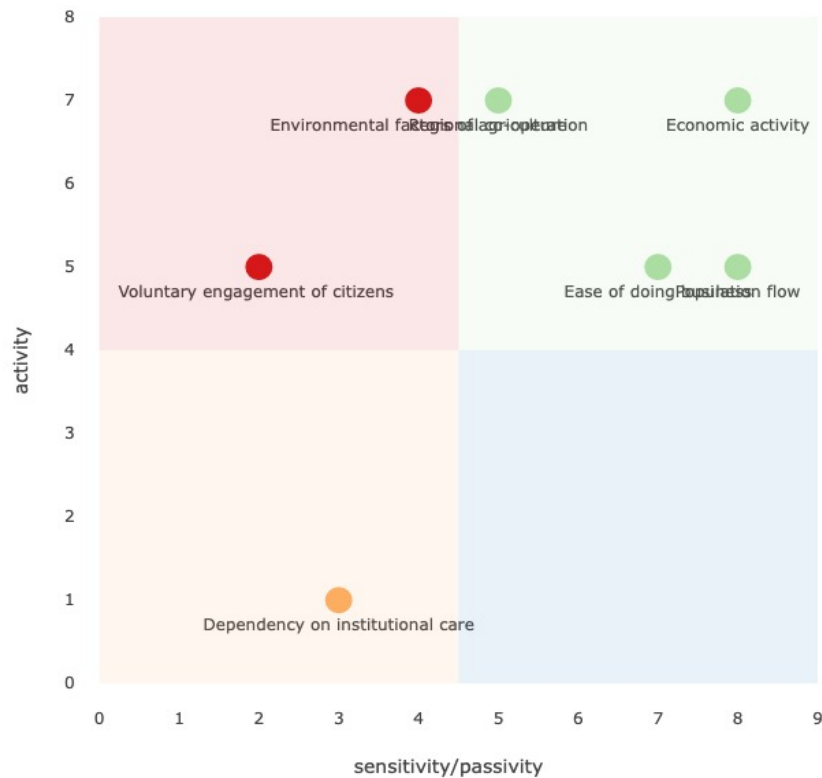


Figure 11: System Grid for VS01 Impact Factors. (Source: authors)

3.2.2. Evaluation Criteria

To carry out a scenario-based vulnerability analysis for Langau, criteria need to be selected for the assessment process. The chosen criteria should aid in evaluating the ability of the social infrastructure of Langau to cope with exposure to different threats. The evaluation criteria for this project was developed by the facilitators and revised with the experts.

3.2.2.1 Initial Evaluation Criteria

An initial list of 7 evaluation criteria (see Table 5) was drafted by facilitators and sent to experts via e-mail for feedback and comments a little over a week before the stakeholder conference. The initial list had no accompanying descriptions, which was one of the recurring feedback received and so each expert likely understood the criteria differently. In column 3 (Table 5) experts provided feedback on the drafted evaluation criteria, while in column 4 they proposed alternative evaluation criteria. 5 experts from science provided initial feedback while no experts from practice were able to provide feedback before stakeholder conference.

Table 5: Evaluation criteria (also called vulnerability assessment criteria) and expert feedback before the first stakeholder conference.

	Evaluation Criteria	Experts's comment on proposed Evaluation criteria	Expert's proposed Evaluation criteria
u_1	Quality of life and wellbeing	- Define quality of life and well-being to include Economic Opportunities, Community, Environment and Health	-Demographic diversity-demographic structure of the population - Ecological diversity - Share of working age population -Share of daily commuters (including pupils) - Migration rate (in and out) -Participation in democratic processes: share of active voters, members of political parties - No. of children born

u_2	GDP per capita of the community	- GDP is a controversial indicator, new approaches like an economy for the common good could offer better assessment - Not a good evaluation criteria because community members might be working somewhere else	- Economic opportunities available - Unemployment rate - Youth unemployment - Number of adults without qualifications - Rural income per capita, - Housing affordability (ownership)
u_3	Mortality/ morbidity rate of the vulnerable population	- Define vulnerable groups in Langau, - Not an Evaluation criteria but more of outcome measure	- Rural mortality rate, infant (per 1,000 live births) - Rural mortality rate, adult, female (per 1,000 female adults)) - Healthy life expectancy - Share of people above 65 - No. of people with chronic disease/ in permanent care
u_4	The capacity of health facilities to manage an increased number of patients	- The EC should focus also focus on the self-efficiency of citizens regarding their health	- Distance to the nearest hospital, - Availability of a GP in the community - No. of patients a GP can cater to on a regular basis (and in extreme cases) - Availability of services offered for sick people without cars - No. of healthy days at home - No. of sick days - Hospital beds (per 1,000 rural people) - Physicians (per 1,000 rural people)

u_5	The attitude of the citizens toward community resilience	-Define 'resilience' in the context of the study - Could be difficult to measure attitude - EC should also consider openness to individuals responsible for making communities resilient	-Use community members' well-being as a measure i.e. self-reported happiness, satisfaction, self-reported worthwhile, self-reported anxiety -Participation rate at information events
u_6	Interest and engagement of the citizens in voluntary organisations		-Community cohesion, - Local election turnout -Volunteer opportunities, (charitable) donations -Community engagement rate -No. of unions (& number of members), - No. of donations
u_7	The continued supply of quality utilities and community services to the citizens	-Define quality utilities and identify the quality utilities of the community -EC should include assessing the quality of public transport- how well can people commute to the nearest community centres	- Opening and Closing hours of services - Rural health care (% of rural population with access) -Access to services (distance) - Broadband -Rural social services (% of total expenditure) -No. of public buses that transit to nearby centres (& schedules: what's the earliest/ latest connection?), - Car ownership ratio of adults - Rural school enrolment

u_8		- Assuming resilience for Langau includes environmental aspect, it's important to include evaluation criteria related to the environment-	Possible indicators for environmental criterion: -Nature access -Air pollution: multiple pollutants -Air pollution: nitrogen dioxide -Green space access -Crime -Environmental concern -Environmental behaviour -Renewable energy use - Recycling
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3.2.2.2 Revised Evaluation Criteria

The list of 7 evaluation criteria, including a suggested 8th criterion derived from the initial feedback was presented to the experts (both scientists and practitioners) at the stakeholder conference. As a result of the discussions during the conference, the evaluation criteria changed to suit the new guiding question and a final list of 6 criteria and their descriptions was developed (see Table 6).

Table 6: Evaluation criteria after the first stakeholder conference.

	Evaluation criteria	Short definition	Experts input
u_1	Social cohesion	- the extent of reliability among people to depend on one another	- Solidity of the sense of identity/"we" - Community interdependence - Measured by survey
u_2	Economic Vitality	- health and well-being of the community's economy, including economic activities or processes that are	- Number of SMEs in the region - Availability of job opportunities in Langau and in neighbouring towns - Unemployment rate

		contributing to the economy of the town	- What's the share of employees in precarious/ limited/ part-time jobs?
u_3	Demographic diversity	- the presence of different age groups of people within the community	- Measured by percent of population by age - Which age group is dominant? -
u_4	Community care	- Willingness of community members to care for one another	- Preventive medicine and care, - Including health awareness and literacy - Community nursing and healthcare centre
u_5	Basics autonomy	- ability of the municipality to provide and meet basic utility needs of the community	- Continued supply of - Water, - Quality soil for farming, - Energy - Food. - Access to broadband - Affordable short-distance and long-distance transportation means
u_6	Ecological regeneration	- improving the health of ecosystems so that they can better support plants and animals and the needs of the community	- Initiatives related to soil protection, improving water drainage, forest regrowth

3.2.3 Risk, Adaptive Capacity, and Vulnerability

The evaluation criteria discussed in the previous section are used as part of a multi-criteria assessment to determine the sensitivity of Langau's social infrastructure when exposed to different threat scenarios. Due to various limitations, the multi-criteria evaluation of the scenario was done internally by the facilitators, without expert input. One facilitator designed the exploration course and all six facilitators (including the designer) participated in the exploration course, to weigh (w_j) and provide their individual assessment of the importance of

each criteria in connection to Langau's vulnerability. Since the exploration course was done individually each facilitator weighed the importance of the criteria differently.

The exploration course was divided into five sections, three of which required input regarding evaluation criteria and this discussion will be limited to them. In the first part, facilitators weighed (w_j) the importance of each criteria for the future of Langau. The initial value for each criteria was 50, this could be increased or decreased such that the more important criteria should have higher scores. The average of these weights for each evaluation criteria is shown in the graph in figure 12. In the second part the facilitators weighed the six evaluation criteria in consideration of the scenario 'Business as usual' which denotes that if Langau's system continues as is (in the way it currently operates in the present) and no external threats arise, what would Langau's system look like in the next 20 years (2043). Each criterion was set at the initial value of "100" and the evaluating facilitators were required to use a slider to rate the change in performance of the criterion on a scale of "0" to "200". Here 100 meant the performance of the system in that evaluation criteria won't change from the status quo, decreasing to less than 100 meant it will deteriorate, and increasing beyond 100 meant it will improve from the status quo.

In the third section, the facilitators' task was to evaluate the (reduced) performance of the development scenario 'Business as usual' when exposed to three threat scenarios (Health Crisis, Societal Breakdown or Economic downturn). The section provided a written narrative of the three scenarios and under each scenario there was an evaluation scale of the six evaluation criterion. The initial value was once again set to "100" for all criteria. The evaluating facilitators were required to read each narrative and then use the sliders with a scale of "0" (worst conceivable performance) to "200" (best possible performance) to rate the changed performance of the evaluation criterion when exposed to the threat scenarios.

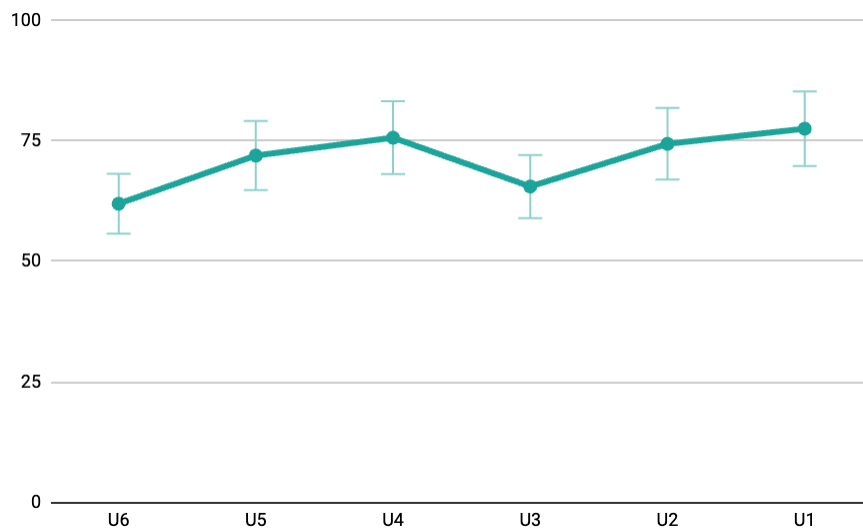


Figure 12: The average weight ($\bar{w}_j$) given to each evaluation criteria by facilitators to indicate the relative importance of each criteria. Reference weight is 50. (Source: Authors)

Having the Risk and Adaptive Capacity scores, it is possible then to calculate the vulnerability score of a system. Vulnerability is a function of Risk and Adaptive Capacity. According to the SVIDT method, the vulnerability score can be calculate using the formula

$$Vul = R \times (1 - AC)$$

where R is the risk score and AC is the adaptive capacity score. This relation between these three variables means that a system is most vulnerable to threats that 1) pose a greater risk of system performance disturbance and 2) the system has less adaptive capacity to deal with it.

4. Results

4.1 Risk Assessment

4.1.1. Threat Scenarios

A threat scenario is constructed by putting together a combination of threat variables at different high/low states and transforming it into a narrative. In this way, 128 ($=2^7$) theoretical threat scenarios could be constructed. However, not all of these combinations could make a consistent threat scenario narrative. To select the consistent threat scenarios, the facilitators constructed a consistency matrix, where the consistency of mutual occurrence of the high and low states of each threat variable against the other threat variables were evaluated with a range of -99 (impossible), 0 (possible), 1 (probable), 2 (highly probable). This evaluation was done through discussion and consensus among the facilitators.

Based on the constructed consistency matrix and following the Formative Scenario Analysis method, a consistency score was calculated for each of the 128 theoretical threat scenarios. Moreover, using the k-means clustering algorithm, these scenarios were grouped based on their similarities into three clusters. A representation of these three clusters can be seen in figure 13. Finally, from each cluster of threat scenarios, the top five scenarios with the highest consistency score were picked and analysed among the facilitators to choose one scenario from each cluster with the best possible narrative.

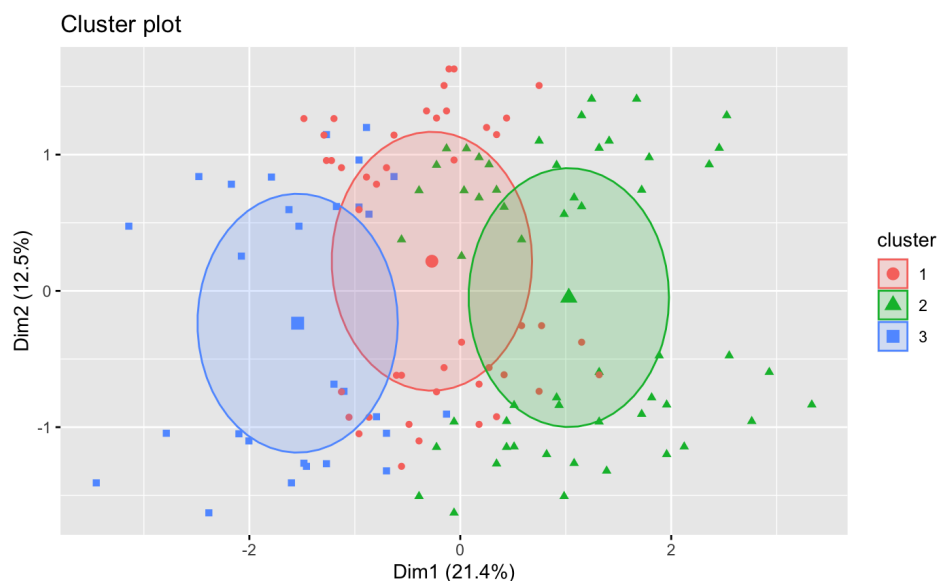


Figure 13: Three clusters of threat scenarios identified using the k-means clustering algorithm for a space of total 128 threat scenarios constructed out of 7 threat variables. (Source: Authors)

Status quo/ Business As Usual Scenario (S0)

The urban population of Austria has constantly increased since 2011. In 2021, 59% of the population were already living in urban areas, the net migration rate of Langau remains unchanged (d1). As there is not much demographic change and no severe health crisis has affected Langau, the average number of days of inpatient stays in acute hospitals remains around 6.3 days leveraging Austria's national rate (d2).

Due to the sustainability and climate adaptation strategies of the government of Austria, Langau has not been affected by a severe climate disaster yet. Hence, the economic activities run normally (d5, d7). However, since the municipality has been taking on long to hold discussions with other towns in the region for economic and social cooperation, not many new businesses or regional collaborative projects have been initiated (d4, d3, d6).

Threat Scenario 1 (T1) - Health Crisis 2038

Key: HIGH Population flow (people moving to Langau), HIGH Dependency on institutional care, LOW Civic engagement, HIGH Regional co-operation, HIGH Environmental factors of agriculture (good conditions for agriculture), HIGH Ease of doing business, HIGH Economic Activity

By the year 2038, the population of Langau has increased by 12 percent along with the increase in the global net migration rate (d1). Langau has formed more initiatives than ever in collaboration with nearby towns to promote regional cooperation towards promoting local businesses and supporting sustainable rural development strategies (d4).

The agricultural industry of Langau and nearby towns have developed due to advanced farm technologies for better irrigation systems and the use of solar and biothermal energy for farm operations, which has contributed to maintaining high soil health scores and implementing better crop patterns (d5). These factors have contributed to the increase in crop production, boosting agricultural businesses and attracting more investors and labour force to support the economic activities centred around agriculture. To support the demand of a higher population, other relevant businesses such as supermarkets, and soil and crop protection services, have started opening in the town (d6,d7). The promotion efforts of the town of Langau in regional cooperation has allowed businesses, both in Langau and in nearby towns to increase trading activity and expand their business sizes. (d4,d7)

Although the social and economic sector of Langau has been developing, the health sector is struggling due to 1) an increase in the ageing population, which requires additional nursing and home care services, 2) an increase in health services demand and day patient cases, and 3) a higher likelihood of having an insufficient number of health care workers to serve a larger population. If Langau has been affected by a pandemic or an increase in certain diseases (such as chronic or diabetes), the stress on health sector capabilities will be aggravated (d2).

Threat Scenario 2 (T2) - Societal breakdown 2043

Key: LOW Population flow (people moving out of Langau), LOW Dependency on institutional care, LOW Civic engagement. HIGH Regional co-operation, HIGH Environmental factors of

agriculture (good conditions for agriculture), LOW Ease of doing business, LOW Economic Activity

According to World Bank's statistics, the urban population of Austria has constantly increased since 2011. In 2021, 59% of the population are already living in urban areas. In the year 2043, 70 percent of the population are living in urban cities for better job opportunities and living conditions. Between 10 - 12 percent of residents from Langau, especially those aged between 18 to 35 years, have moved to other towns, mostly urban areas, for better education and job opportunities (d1).

The agricultural industry of Langau and nearby towns have developed due to advanced farming technologies creating better irrigation systems and the use of solar and biothermal energy for farm operations, which has in turn contributed to maintaining high soil health scores and better crop patterns(d5). However, since a major part of the labor force has moved out of Langau, the economic activities around local consumption and production have slowed down, which has led to a drop in newly opened businesses and an increase in closing businesses (d6, d7).

Due to the population decline, there is less dependency on institutional care, except for some regular on-demand healthcare services (d2). There has also been a decline in community activities and civic participation; however, Langau's municipality has managed to strengthen regional cooperation to boost civic engagement (d3, d4).

Threat Scenario 3 (T3): Economic downturn 2033

Key: LOW Population flow (people moving out of Langau), LOW Dependency on institutional care, HIGH Civic engagement, LOW Regional co-operation, LOW Environmental factors of agriculture (bad conditions for agriculture), LOW Ease of doing business, LOW Economic Activity

The year 2033 has seen huge waves of climate crisis which in turn has led to natural disasters, negatively affecting different sectors in Austria. Similar to other towns, Langau has also experienced severe drought during the crop season of the year 2033. Even with advanced irrigation systems, crops can barely survive on affected soil (d5). This has led to a huge financial loss for agricultural businesses and has impeded the potential of new businesses to open in the town (d6,d7).

According to World Bank statistics, the urban population of Austria has constantly increased since 2011 and in 2021, with 59 percent of the population already living in urban areas. In the year 2043, 70 percent of the population are already living in cities for better job opportunities and living conditions. Between 10 - 12 percent of residents from Langau, especially residents aged between 18 to 35 have moved to other towns, mostly in urban areas, to get a better education and job opportunities. The economic downturn caused by climate change has also contributed to the outward migration of the Langau population to other towns (d1).

4.1.3 Risk Scores

The three threat scenarios defined in the previous section were evaluated using the MCA method against the 8 evaluation criteria defined in section 3.3.2. This evaluation was done by the 6 facilitators and the result can be seen in the chart in figure 14. According to this chart, The economic downturn (T3) imposes a threat of 28% performance reduction and stands on top. After that, societal breakdown (T2) follows closely by an 18% performance reduction. Health crisis (T1) poses the least risk, with only 8% performance reduction.

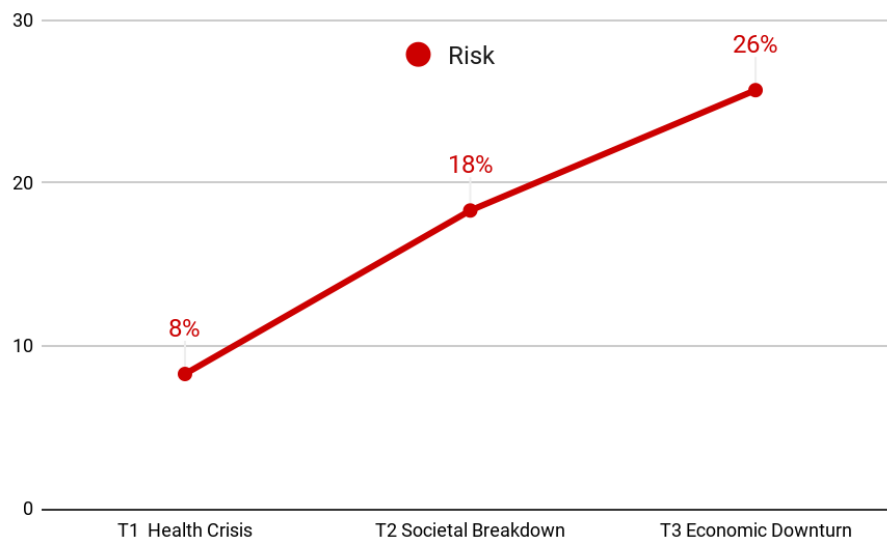


Figure 14: Evaluation of risk for the three chosen threat scenarios. (Source: Authors)

4.2 Adaptive Capacity

To evaluate the adaptive capacity of the community of Langau against the identified threat scenarios, first, a bundle of seven intervention scenarios was constructed by the facilitators as possible measures to counteract the posed threats. Afterward, the expected performance improvement due to these interventions was evaluated by the facilitators using the MCA method and used to calculate the adaptive capacity scores.

4.2.1 Bundle of Intervention Scenarios

The bundle of intervention scenarios was constructed by the facilitators using the insights from the stakeholders conference by thinking about measures to counteract each of the threat scenarios discussed in section 4.1.1. The complete list of seven intervention scenarios can be seen in table 7 below.

Table 7: List of Intervention Scenarios along with their description.

	Intervention scenario	Description
i_1	Increased investment in community nurse projects to attract further nurses.	The community nurse project can provide preventive care services such as vaccinations and health screenings [1]. They can also provide education on healthy living and disease prevention (Morris, 2020). Additionally, they can help identify and manage chronic conditions such as diabetes and hypertension [3]. Improving community nurse services can minimise the need to visit hospitals and avoid or delay the need to receive professional medical treatment.
i_2	Building a small healthcare facility through regional initiatives to serve Langau and neighbouring towns.	In addition to community nurses, some basic healthcare infrastructure can improve by providing access to healthcare services that are not available locally (St Clair, 2018). This can help reduce the spread of infectious diseases and other health threats by providing early detection and treatment (World Health Organization: WHO, 2020). Additionally, it can help improve the overall health of the community by providing preventive care services such as vaccinations and health screenings (Centers for Disease Control And Prevention, 2022).
i_3	Improving infrastructure to attract more remote workers.	Since the Covid outbreak, the possibilities for remote working have substantially improved (Lund et al., 2020). This has opened a new window of opportunity for small towns like Langau to attract people who like to live in the town (because of family connections, or simply to enjoy the countryside) (Gaskell, 2020). The infrastructure required to make Langau more remote-working-friendly includes broadband, basic services including grocery shop, cafe, restaurant, decent housing and minimum recreation options.
i_4	Improving infrastructure to attract more tourists	Stimulating tourism can create jobs and boost Langau's economy (Al-Khateeb, 2021). It can also help diversify the economy and increase revenue streams [10].

		Additionally, it can help preserve local culture and heritage by promoting local traditions and customs (Saarinen & Gill, 2018). Langau can invest in improving tourist attractions, accommodation options and relevant services.
i_5	Incentives for new businesses starting in Langau.	Langau could offer incentives such as tax breaks, grants, low-interest loans, and other financial incentives to attract new businesses. It could also offer land or buildings at reduced rates or provide assistance with site preparation. Additionally, it could offer training programs for employees or provide assistance with marketing and advertising. Such incentives can foster economic activity and create more job opportunities while diversifying the town's economy.
i_6	Grassroot level community initiatives on environmental regeneration	Community initiatives at grassroots-level to tackle environmental issues can promote sustainable development and reduce environmental risks in the town (Wang et al., 2022). It can also help build social capital and foster community engagement (Patrick-Agulonye, 2021). Additionally, it can help create a sense of ownership among community members and promote local leadership (World Wild Life, n.d.). These initiatives do not need to be large-scale, but small ones, such as planting trees, to help keep the community close-knit with each other.
i_7	Training and investment into resilience measures against climate change	Residents, especially farmers can benefit from training and investments into sustainability and climate change mitigation. For instance to prepare drought-resilient soil and agriculture and using more efficient irrigation systems.

4.2.2 Adaptive Capacity Scores

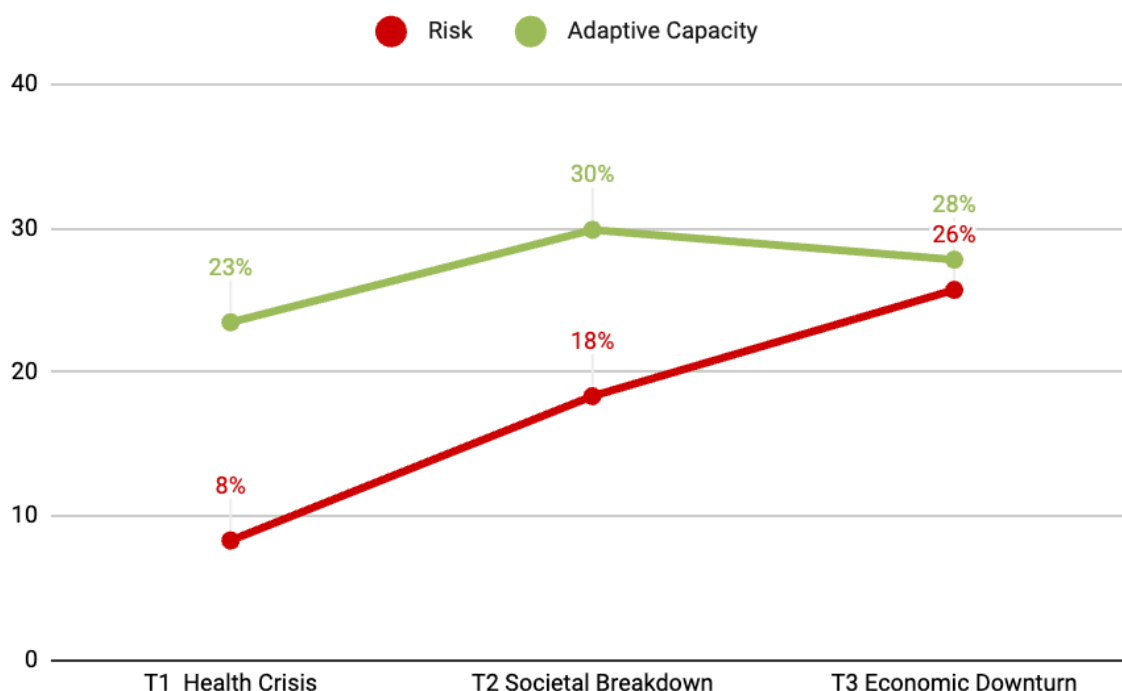


Figure 15: Calculated risk and adaptive capacity scores associated with each of the three identified threat scenarios for Langau. (Source: authors)

Based on the evaluations of the 6 facilitators, out of the three threat scenarios, Langau has the highest adaptive capacity to deal with a societal breakdown scenario and the least adaptive capacity against the health crisis scenario. To provide a better understanding on the derivation of adaptive capacity, the Economic downturn threat scenario will be discussed here.

Example: Adaptive Capacity against Economic Downturn

As narrated in the scenario in section 4.1.2, in 2033 Langau experiences various challenges. Some of these include a climate induced drought which results in crop failure and a decline in agri- businesses, while also creating unfavourable economic conditions for new businesses. The general population of Langau is migrating to other towns, especially young people who are moving to more urban areas. Against the backdrop of these conditions, the facilitators evaluation scores provide that Langau has an adaptive capacity of about 28%.

This means that it is expected that when the community of Langau fully implements all measures of intervention i_1 to i_7 (see Table 7) this would reduce the risk score (performance loss) of the economic downturn scenario by 28%. By providing farmers with training on resilience measures against climate change (i_7), farmers will for instance be able to use the knowledge and skills gained to effectively practise drought-resilient agriculture thus reducing risk of crop failure and providing a stable supply of high-quality products, which in turn also increases income and investment in agribusinesses. This will boost entrepreneurship innovation and economic activity in general which could lead to increased employment, higher incomes, and improved food security for the Langau community.

If Langau additionally implements grassroots-level initiatives on environmental regeneration (i_6) such as planting trees initiatives, this would not only provide numerous environmental benefits such as improving air quality and mitigating climate change but it would also strengthen the social cohesion of the community by bringing people together for such activities.

Regeneration initiatives can also be an avenue for creating new job opportunities in areas such as reforestation, and eco-tourism which can boost economic activity. Assuming Langau also moves to give incentives for new businesses (i_5) and improve infrastructure (i_3 , i_4) such as broadband coverage services, this would not only improve economic growth but is also likely to attract more people to live in Langau.

If Langau additionally increases investment in community nurse projects (i_1) and builds a small healthcare facility (i_2) apart from improving the healthcare of the community, this would create job opportunities in Langau and attract more young people to the town, which would also in a manner boost economic activity in the town. Overall the evaluating facilitators estimated that the bundle of the intervention measures discussed in this section (also in 4.2.1) would enhance Langau's capacity to adapt to any impending economic downturn in the future.

4.3 Vulnerability Assessment

The Risk and Adaptive Capacity scores from the previous two sections were used to calculate Vulnerability scores. The results can be seen in the chart in figure 16. According to this chart, Langau is most vulnerable to Economic downturn (19%) and least vulnerable to a health crisis (6%). Further, it can be seen that although the risk of Societal breakdown (T2) was relatively high, the vulnerability of Langau to this threat is less, due to higher adaptive capacity this community sports to deal with such a threat scenario.

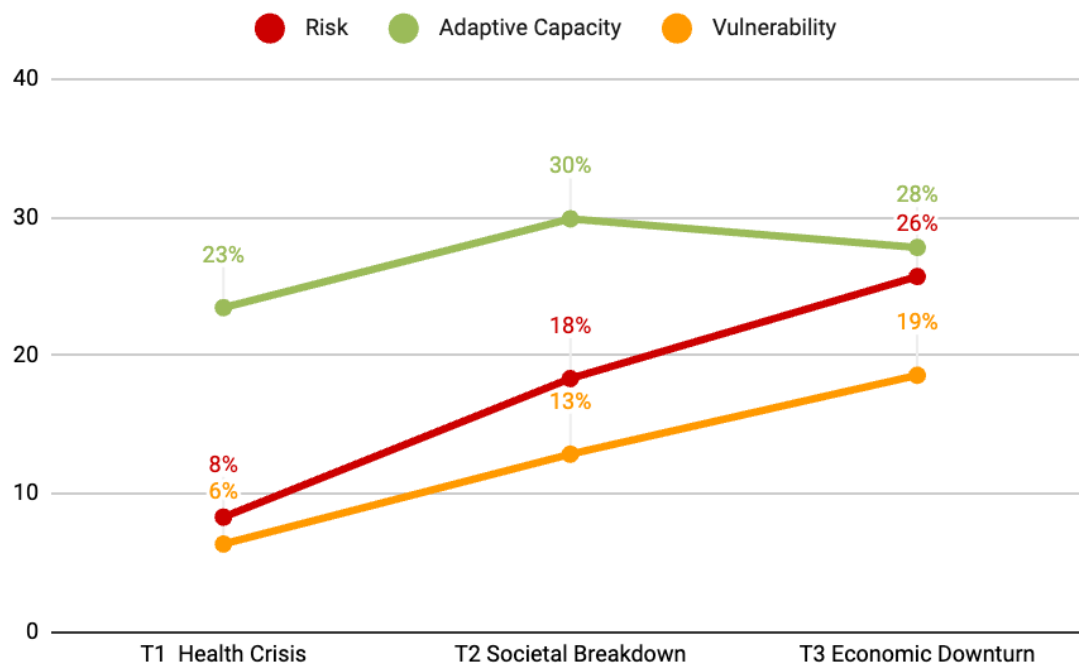


Figure 16: Calculated risk, adaptive capacity, and vulnerability scores associated with each of the three identified threat scenarios for Langau. (Source: Authors)

5. Discussion and Conclusion

5.1 System and Problem Statement

The objective of this project was to do a systematic assessment of the vulnerabilities of communities in order to build socially robust orientations. These orientations can provide solutions towards the resilience and sustainability of these communities in face of different threats including climate change, health crisis, and economic crisis. VS01 team had conducted two cases; one was conducted in the city of St. Pölten and second was conducted in a town near the Austria-Czech Republic border called Langau. The case of St. Pölten unfortunately failed due to the limitation concerning societal preparedness for a Transdisciplinary process in their city. The local management already had key consultants on board to help them regarding disaster management towards a resilient sustainable city. Therefore, with the help of the teams' facilitator Prof. Ilja Steffebauer and his personal connection with one of the key stakeholders of the project (Christine Rottenbacher - Scientist) and their affiliation with the Mayor (Franz Linsbauer - Practitioner) of Langau, VS01 team were able to conduct the Transdisciplinarity project in a new system.

The initial research about Langau led to some insights about its structure; how Langau is mostly surrounded by agricultural fields, and has a small population of over 700 for the last 20 years. The approach of the guiding question took the lens of seeking insights on how Langau would function and survive in a time of poly-crisis such as pandemic which caused global disruptions. However, after the first stakeholder conference, the feedback from all the scientists and experts concluded that instead of building resilience of the town of Langau in poly-crisis, the real approach they see is in building adaptive capacity of their social infrastructure which they consider very crucial towards the sustainable development of Langau in the future. Characteristics such as social cohesion within the community of Langau were considered extremely important by the population and securing a sense of “We” as a community was more important for them towards sustaining Langau in the next 20 years.

5.2 Project Management

In managing the project, both internal and external factors were considered to ensure its success. From the beginning, team members divided tasks among themselves according to their strengths in order to contribute fairly to the work. For the stakeholder conference, certain members were responsible for contacting stakeholders, communicating with professors to ensure that we follow the TRFT process. During the conference specific members were responsible for conducting the conference, taking notes, and technical aspects. There was also a division of tasks in the creation of the presentations. Some team members designed the layout while others filled in the content. When writing the reports, members divided the chapters they wanted to write about. Google calendar was used to schedule internal meetings, and a Google Excel spreadsheet was used to manage tasks, documenting progress at each stage. Google docs was used extensively for collaborative writing purposes. By dividing tasks and using effective tools, the team was able to manage the project efficiently, resulting in a successful outcome.

5.3 Stakeholders

Regarding the involvement of stakeholders in the project, having a diverse mix of science experts that align to the themes of the guiding question around this transdisciplinary process has been pivotal to drawing insights into key frameworks and trends into issues such as public health, environmental sustainability and social cohesion, among others, that enriched the discussion. Having practitioners who are decision-makers involved in this process has also been critical in identifying priorities of the Langau community, making the discussion more directed and relevant.

5.4 Knowledge Integration

Throughout the research, systemic integration was conducted through preliminary desk research, which could have been further enriched through field research. Epistemological integration was achieved by integrating feedback from scientists on guiding questions, impact factors, and evaluation criteria. Cognitive integration was stronger than cultural integration,

but cultural factors could still be picked up in discussions and comments. Stakeholders' modes of thinking were significantly influenced by the societies, groups, or professions they belong to. They were also community-oriented and enthusiastic about achieving a common goal, but interest-driven perspectives were also discussed. Hence, it has been a rewarding experience with different levels of knowledge integration being integrated by stakeholders and the research team.

5.5 Limitations

The main limitation of this project was time, which resulted in a condensed version of the Transdisciplinarity process, with limited input from the stakeholders. Ideally, input would have been sought from stakeholders during the development of the various scenarios i.e. Business as usual, threat scenarios and the intervention scenarios, to ensure that they reflected a true picture of Langau as agreed to by stakeholders. Stakeholders should have also been asked to input their ratings in the exploration course that resulted in the risk, vulnerability and adaptive capacity scores discussed in this paper.

Since stakeholders did not provide input at the stages discussed above, the results of this paper should not be considered conclusive but rather the paper should be regarded as a preliminary exploration into the adaptive capacity of Langau which requires further investigation to confirm the findings.

Further, a second stakeholder conference has to be held in order to discuss the results of the vulnerability assessment with the stakeholders, with the aim of consolidating socially robust orientations (SoROs) that would help stakeholders to build a more resilient and sustainable Langau in face of future threats.

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