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## 9. Capacity development and knowledge transfer on the climate, land, water and energy nexus

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### 9.1 INTRODUCTION

Applying the concept of the nexus of climate, land, energy and water systems (CLEWs) to sustainable development requires the integration of knowledge from different disciplines to solve complicated multi-systems challenges.<sup>1</sup> Such knowledge and expertise are not solely situated in scientific research's theoretical realm (i.e. branch of knowledge). For the approach to be successful, integration is also required in a variety of decision spaces. The development of nexus knowledge, which we define as information related to systems' physical, natural and socioeconomic interactions, broadly emerged from project-oriented research and case study applications, extending the system's coverage to several resource systems, climate and governance. Discussions among the scientific community, particularly linking development challenges to the functioning of systems and management of resources, guided the agenda of nexus studies throughout the 2010s (Bazilian et al., 2011; Hoff, 2011; Ringler et al., 2013). In this context, knowledge creation happened informally, very much shaped by the teams' expertise and experience conducting the nexus assessments, the stakeholders involved in the projects and their degree of participation.

Nexus knowledge can be used for different purposes depending on the type of actors involved under a specific nexus context and the assessment's aim. Several authors point to the need for interdisciplinary approaches to address complex challenges (Hicks et al., 2010; Reid et al., 2010; Smajgl and Ward, 2013; Wolfe et al., 2016), as opposed to the more conventional siloed approach to policy design and decision making. In the latter, sectoral policies have no or limited consideration for cross-system impacts and dependencies. The integrated approach considers such interrelations in the preparation of sectoral plans and strategies compatible with multi-sector development. Planning, especially policy-making, which is informed by a nexus approach, is an exercise in dealing with trade-offs between sectors. Knowledge of different systems beyond the sector of work and their requirements from other systems and sectors could facilitate communication and collaboration between institutions, leading to more sound, comprehensive and integrated policies and strategies. Learning about the nexus is unavoidably the first step in a nexus study for any new practitioners. Hardly a single specialist gathers interdisciplinary knowledge with an equivalent level of specialisation. Thus, achieving multi-disciplinarity for multi-system problem solving requires building baseline knowledge of the nexus across an ecosystem of systems and by a pool of cross-sectoral actors. This base

knowledge is necessary for communication between actors involved in the assessment and the successful dissemination of the approach within their (actors') organisation and networks.

Even for experienced nexus experts, learning is still present when engaged in a nexus assessment. On the one hand, knowledge is required to conduct nexus assessments, implicitly leading to learning opportunities; on the other, knowledge about the nexus is also generated. This new knowledge can later retro-feed into the initial nexus learning process. Hence, there is a continuous stock-taking of experiences across several projects such as nexus issues, examples of trade-offs, sets of solutions and the processual expertise gained from conducting an assessment, to list a few. This informally gathered body of knowledge is vast but specific. Thus, it needs to be transferred to raise awareness of nexus implications, leverage integrated systems analysis and facilitate the permeation into decision-making processes. The siloed approach to planning and decision making is still the standard approach (Howells et al., 2013). However, there is increasing evidence pointing to a shift towards more collaborative approaches at various decision levels. An example is the expansion of capacity-building activities in nexus modelling (UNDESA and UNDP, n.d.), or the number of research projects and calls related to the nexus (European Commission, 2020). Reconciling the two approaches (siloed and integrated) would confer flexibility to planning processes and sound decision making. Thus, nexus knowledge needs to be present in the planning environment as transversal and cross-cutting skills (e.g. systems-thinking, and integrated systems analysis).

Several approaches exist to guide the examination of the interconnections between resource systems and services that aim to inform policy and decision-making processes. Examples of nexus assessment frameworks include the Food and Agriculture Organization (FAO) Water-Energy-Food Nexus (Flammini et al., 2014), the transboundary nexus assessment methodology (de Strasser et al., 2016; UNECE, 2018b), the Water-Energy-Food Nexus Tool (Daher and Mohtar, 2015; Mohtar and Daher, 2016), the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (Giampietro, 2013), the SIM4NEXUS Nexus assessment framework (Ramos et al., 2020), the Nexus Solutions Tool (IIASA, 2020) and the CLEWs framework (Howells et al., 2013; Ramos et al., 2021). In this chapter, we focus on the latter because it has been applied in different learning contexts, from capacity-development activities to nexus dialogues and in academia. The CLEWs framework guides the analysis of interactions between climate, land, energy and water. CLEWs-type research is often supported by the quantitative study of systems interactions and the use of resources by different sectors. In CLEWs, systems are defined at a biophysical level. They contain the activities of the sectors that predominantly use or depend upon the resources available in a system (e.g. coal as a resource of the energy system used in the energy sector or in the sub-sectors of heating, cooking or electricity; or the use of diesel for the transportation or operation of water pumps in the agricultural sector, part of the land system). The majority of the CLEWs applications to date explore resource management, focusing on assessing sectoral policies and on the implications to (and of) the climate system (Ramos et al., 2021).

In this chapter, we present and discuss different approaches to knowledge transfer and development in the nexus approach, as implemented in various applications of the CLEWs framework (Howells et al., 2013; Ramos et al., 2021). The chapter is organised as follows. We first illustrate the importance of learning about the nexus and identify existing channels and mechanisms to transfer nexus knowledge. The next section focuses on activities and initiatives related to the CLEWs framework by presenting examples of how these are structured and conducted and how learning is achieved. Next, enabling factors, opportunities, barriers

and challenges to disseminating nexus knowledge are presented and discussed. We conclude the chapter by summarising key lessons from the knowledge-transfer activities related to the CLEWS framework practice and suggest ways for further improvement.

## 9.2 LEARNING ABOUT THE NEXUS

Learning about the nexus can occur via different routes, namely through formal, non-formal or informal learning. Formal learning is structured, goal-oriented and instructed by a teacher or facilitator, and knowledge is organised in courses, webinars and educational resources to achieve specific learning goals. Such a practice is often associated with a formal certification of the knowledge acquired and found in traditional education settings, such as universities or online-certified courses. Other formal approaches include nexus-related courses (or projects and assignments) at academic and vocational levels in various disciplinary areas. For example, the nexus approach can be included in the curricula of many programmes with different foci (e.g. in hydrology and water management degrees, as it can be included in sustainable energy engineering programmes). Learning about the nexus outside specifically defined programmes that award a certification, such as online courses and summer schools, are other examples of formal learning in the nexus. Also, capacity-development initiatives can be considered formal learning activities. The development of capacity (by individuals, organisations or nations) is a process in which existing capacities are maintained, strengthened and/or expanded to attain development objectives (Ubels et al., 2010; UNDP, 2008). In this chapter, we opt to use the term ‘capacity development’ instead of ‘capacity building’. We assume that capacity already exists and is being developed further as part of an endogenous and continuous process, as opposed to the term ‘building’, which suggests that no capacity existed before the initiatives (UNDP, 2008).

Learning can also be achieved through a *non-formal approach*. A learner takes the conscious decision to learn or master a particular topic and engages in activities or takes action towards learning about the subject. This type of learning does not follow a specific structure nor has an accreditation system. Such an approach can be followed when an expert decides to or is required to expand the knowledge on a certain topic, which can be (or related to) the nexus concept, and the individual defines the learning plan. As non-formal learning methods, we find tutorials, online courses (without accreditation or certification), participation in research and/or interinstitutional projects and nexus dialogues. Non-formal learning activities are structured and aimed at reaching specific goals; however, they are different from formal learning (Rogers, 2014). Learning occurs indirectly when the learner is not pursuing a particular purpose but where the participation in activities results in the acquirement or production of knowledge. In the context of the nexus, it can occur as a result of personal research, as a member of networks and communities of practice (CoPs), participation and/or attendance of conferences and meetings, as well as nexus dialogues. On the latter, and although the initiatives can have overarching goals linked to specific projects, learning can be accomplished indirectly through discussions and talks and stock-taking of current research and learnings from other projects (ongoing or finalised).

When learning activities are unplanned, not framed around specific goals, and self-directed, the approach is known as informal learning. Since this approach is primarily focused on the individual level, its structure is determined by the learner’s actions. Thus, it can be more

structured (e.g. personal research online, books, articles, etc.) or less planned (e.g. as a member of a community, participation in forums and discussions). Informal learning is incidental – meaning that the understanding can be achieved coincidentally. This can be the case of participating in conferences or discussions in meetings, workshops and nexus dialogues.

This section explores how learning has been accomplished in different knowledge-transfer activities embedded in nexus assessments from the perspective of learning approaches. We start by discussing the importance of learning about the nexus and then analyse how it is processed in formal learning contexts and practice.

### 9.2.1 The Importance of Learning

An increasing number of examples of resource system nexus, and their interactions with the climate system, have been identified and investigated at different administrative and geographical scales. These include applications to transboundary watercourses (Lebel and Lebel, 2018; UNECE, 2015, 2018b), coherent management of land and water resources at the national level (Hermann et al., 2012; Howells et al., 2013; Martinez et al., 2018; Sridharan et al., 2020) and water and energy efficiency at urban level (Engström et al., 2017). The 2030 Agenda<sup>2</sup> expanded the dimensions of system interconnectedness within the sustainable development context by introducing the ‘indivisible’ and ‘integrated’ Sustainable Development Goals (SDGs) to substitute the Millennium Development Goals (United Nations, 2015). The launch of the 2030 Agenda unfolded to many a dimension of systems interconnectedness in the context of sustainable development, manifested through the SDGs and their interlinkages. The SDGs and their simultaneous achievement embody the inherent and intrinsic need for integrated planning at multiple levels (Liu et al., 2018; Mohtar, 2016).

Acknowledging the interconnectedness of systems is a critical step in understanding the nexus of systems. It paves the way for understanding context-specific system interdependencies and their implications and facilitates identifying study priorities. Moreover, it allows for understanding complex resource management problems, impacts to and from climate systems, the ramification or propagation that sectoral or system issues can pose to other systems and sectors and feedback mechanisms. Overall, one builds a conceptual understanding of systems and their interactions. Once one begins to internalise the concept of the nexus, the qualitative and/or quantitative interpretation of how linked systems perform and co-exist becomes more transparent and clearer (within the limitations of the detailed knowledge of the systems).

Nexus knowledge also facilitates understanding systems’ representation in modelling tools, the importance of data for systems’ characterisation and the advantages of nexus information systems. Compatible data standards allow for an improved representation of connections between resources use (Howells et al., 2021). At the governance level, nexus knowledge could contribute, and is necessary, to the development of transversal and cross-institutional capacity in several systems. It can facilitate communication between institutions dealing with common resources or that are indirectly impacted by decisions that affect their management (e.g. commerce, finance, employment) (UNECE, 2017). Additionally, it creates opportunities to develop innovative and flexible governance mechanisms that can look into complex cross-system challenges (Gallagher et al., 2016), such as dealing with trade-offs across different institutional barriers.

Several target audiences can be identified for nexus learning. Thus, it is vital to identify the possible entry points for the transfer and development of such knowledge in various contexts

in which the concept is being explored. In a nexus assessment, frequent entry points to knowledge transfer are the nexus system's stakeholders participating in the assessment. Often, the study necessitates the involvement of a cross-sectoral multitude of actors (e.g. from the public sector, business or private sector, research and academia, international organisations, and civil society). These are engaged with the operation and function of the systems in different ways or levels. Some may be responsible for the decisions that influence system services, while others could affect the systems by means of their behaviour. Although we will not explore how different actors affect the systems, we observe their connectedness to strengthen the argument for learning about the nexus. One should not forget the individuals who can potentially become stakeholders in a nexus assessment context. Building the foundation of systems thinking and of the nexus concept during the different stages of academic studies could streamline the incorporation of the integrated systems approach in decision processes.

### 9.2.2 Learning about the Nexus in Formal Education Processes

Over time, nexus knowledge has been built from practice and research. An increasing effort exists in formal education contexts to organise and structure nexus knowledge for learning in academic and vocational education providers. Such work has motivated lectures and courses in these institutions and the organisation of summer schools. The retrospective and iterative process of creating nexus-related learning opportunities is based on reflective and functioning learning. This is so because learners are required to understand system interconnections and multi-system problems. Simultaneously, it is solidly grounded on declarative knowledge in the understanding of individual systems and sectors.

Learning about the nexus can be achieved at different graduate levels. The typical approach is *formal learning*, characterised by structured, goal-oriented activities, with learning generally instructed by a facilitator or teacher. Using the Structure of Observed Learning Outcome (SOLO) taxonomy by Biggs and Tang (2011), we suggest how nexus knowledge can be presented and incorporated in the different degree levels.

At the undergraduate level (first cycle), where students focus on building ground knowledge of specific topics (declarative knowledge), the introduction of the nexus concept could be inserted following an interdisciplinary approach. In this way, students would learn how their subject of study links to and interacts with other disciplines. This corresponds to the third SOLO level, 'multi-structural', in which students are presented with a concept and increase their knowledge quantitatively. However, more learning is required to understand it deeply. More in-depth knowledge could be achieved by developing undergraduate thesis projects on a topic related to the nexus.

At the postgraduate level (second and third cycles), students have already consolidated their learning in specific subjects and topics. They are now equipped with essential skills over which they can expand their knowledge on other inter-related themes. Thus, courses at this level can focus on inter and cross-disciplinary perspectives and, for example, use problem-based learning for examining and solving simple multi-systems challenges. Learning at this level corresponds to the 'relational' SOLO taxonomy level, in which learners go beyond the 'multi-structural' level to acquire a deeper understanding of the concepts. Students engaged in a postgraduate programme often come from different scientific backgrounds. Teaching and learning about the nexus should take advantage of this characteristic. The development of projects, including theses, inspired or motivated by real-world challenges (e.g. related to ongoing

projects) could encourage learning and prepare a new generation of nexus practitioners and decision makers. In the particular case of doctoral studies (third cycle), learners have the opportunity to expand their understanding in a particular field and develop new knowledge. For the nexus concept and research field, it is an opportunity to advance the disciplinary area of the nexus approach. At this level, learning moves beyond the ‘relational’ to the ‘extended abstract’ level in the SOLO taxonomy. The experience and learning gained over these SOLO levels can retro-feed into the planning of courses, assessments and projects. Also, this process supports the continuous improvement of teaching/learning activities dedicated to the nexus and can motivate new nexus-oriented research.

Summer schools are another means for nexus knowledge transfer at all academic and vocational levels. This is an interesting alternative to set programmes that can limit the flexibility in terms of formally recognised learning opportunities. Also, it enables the participation of students and teachers from different levels of education, backgrounds and expertise. The schools we describe even have a wider focus and can be attended by non-academics such as government officials. Such characteristics increase the likelihood of a multi-disciplinarity and enable a creative and innovative environment that could not have occurred in a conventional educational context.

Incorporating the nexus approach as a topic or subject discipline in an academic institution is possible. How and which concepts to explore in each level requires planning for adequately matching ground knowledge (quantity) and complexity (quality, functional knowledge) with the programme outcomes in which it is being included. Participation in summer schools, or activities that enable sharing of knowledge (e.g. conferences, workshops), could provide the opportunity to enrich the knowledge portfolio of the students, provide consolidation with applications to new cases and contexts or even bridge possible gaps in existing programmes.

### **9.2.3 Learning about the Nexus in Professional Development and Practice**

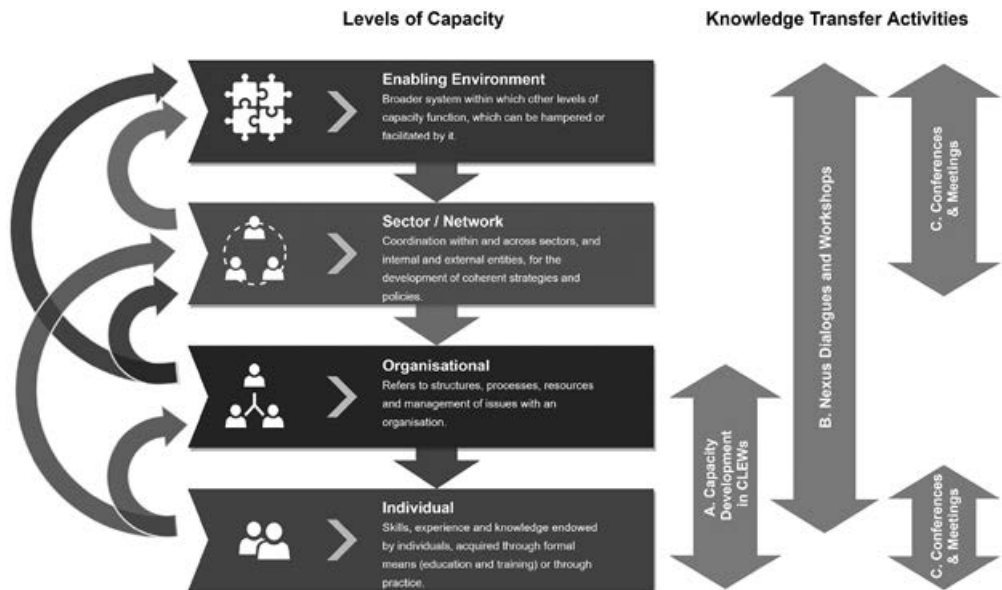
Outside formal education contexts, nexus learning occurs in a mix of formal, non-formal and informal approaches, resulting in a blend of discrete to incidental learning opportunities and skills expansion. In essence, the overall objective of nexus learning in any context will converge learning about systems interactions, assessing them, and incorporating the knowledge in planning processes in whichever context. A more formal approach enables the transfer of specific knowledge within a particular timeframe, as it is designed to achieve specific learning goals. However, learning in non-formal and informal ways can establish a ground for inter, multi- and transdisciplinary opportunities through the acknowledgement of systems interconnections, new associations, identification of trade-offs and/or innovative solutions thinking unexpected to the learner and/or to the community.

In this section, we explore processes of knowledge transfer in the context of the practice of nexus assessments involving established cross-sectoral professionals and stakeholders. In such contexts, the understanding to be developed builds upon existing knowledge and experience. For this reason, we use the term ‘capacity’ to refer to the nexus knowledge being acquired and established in the context of practice. For such, ‘capacity’ is interpreted as the ability of people, organisations and society as a whole (or human system) to manage their affairs successfully (OECD, 2006), but also on their ‘ability to perform, sustain itself, and self-renew’ (Ubels et al., 2010).

When planning for and conducting capacity development involving nexus knowledge, it is important to examine what type of capacity is to be built, which learning approaches could be used, and its implications across the planning and decision-making ecosystem. Such thinking can help design more effective learning activities and programmes that are context-relevant and in line with the end goal of a specific project. In support of this exercise, it is worth looking at the broader role of capacity and its different implications depending on where it is developed.

### Types of learning and levels of capacity

The development of capacity occurs differently at different levels. Learning is one of its fundamental principles (Ortiz and Taylor, 2019). Planning capacity-development activities stems from identified knowledge gaps or weaknesses, or the expected benefits that knowledge advancement can bring at individual and organisational levels or the policy environment. Thus, such activities support specific to broader learning agendas. In the late 1990s, a framework emerged to clarify the levels of capacity (Morgan, 1998), which can be targeted in capacity-development initiatives, which was then adopted by international organisations such as the United Nations Development Programme (UNDP). The levels follow a hierarchy of capacity from the individual to organisational, sector/network and enabling environment. In combination, they form an integrated system (UNDP, 2008). All levels interact and interface with the previous and the next. The ‘capacity levels’ framework, depicted on the left-hand side of Figure 9.1, schematically illustrates the top-down and bottom-up relations that can serve as entry points for capacity development.



Source: Based on Bolger (2000) and UNDP (2008).

Figure 9.1 CLEWs capacity development and nexus dialogues in the context of the levels of capacity

When planning a capacity-development programme for a specific entry level, planning teams should consider the implications to other levels of capacity from implementing the programme. They should also take into account the different ways that learning can be achieved. When capacity is built at the individual level or in small-scale organisations, it tends to be more technical and specific to tackle the lack of skills, enhance individuals' knowledge on particular topics or be part of planned professional development. Here the learning approach is formal, with specific learning goals. The to-be-developed capacity is not always analysed from the organisation's perspective, e.g. how the organisations will benefit from the new or upgraded knowledge and if conditions are gathered for professionals actually to make use of the new skill set. Such a type of exercise is needed for new capacity to be consolidated and benefit the organisation as a whole. At the organisational level, capacity development tends to focus more on the structural, resources and management levels; and this is a common entry point for donor agencies. Emphasis is given to technical assistance (which can then target individuals as part of the organisation), the establishment of cross-institutional connections and funding or infrastructural support. Similarly to the 'individual' level, the learning approach tends to be predominantly formal. Collaboration and coordination efforts within and across institutions characterise the sector/network capacity level. Due to its broader scope, initiatives can focus on sub-sector or sector levels or be framed under specific themes. Learning realised at this level is less easily measured and evaluated, and challenging to predict or plan for. Thus, non-formal and informal learning of the nexus dominates the knowledge-transfer processes since the learning is not actually planned but fulfilled as a consequence or indirectly requested from professionals in the network (who may carry out their research or be involved in activities that facilitate such knowledge transfer and creation). Targeting this level of capacity can enable the establishment of synergies and the utilisation of existing capacity, and the design of capacity-development initiatives that strengthen and expand capacity in a broader but strategic way. The enabling environment is the highest level of capacity and refers to the wider context where development processes occur. The enabling environment can be enabling, constraining or both (Bolger, 2000). Due to its high level, capacity actions in this context slowly reflect on other levels of capacity. These relate to policies, attitudes and values; bottom-up initiatives take time to affect them.

### **Entry points to nexus learning**

Different entry points can be identified in CLEWs-type nexus activities linked to specific capacity dimensions. Correspondence between these activities and the levels of capacity is illustrated in Figure 9.1, on the right-hand side. Longer-term capacity-development interventions, such as in CLEWs training and workshops (identified with 'A' in Figure 9.1), aim at developing modelling and planning skills at the individual level. If participants are involved from an organisation's perspective, such programmes envisage impacts and benefits at the organisational level. If different institutions are involved, the initiative acquires a network level where collaboration can be established. Developing similar capacity across different organisations and sectors can support a specific vision as a coordinated effort at the enabling environment level. It can also promote the design of a more ambitious vision. A less aligned enabling environment can counteract the capacity-development programme's effects if opportunities for using the capacity developed are not created or supported. Examples of activities which typically target the 'individual' and the 'organisational' capacity dimensions include the United Nations Department of Economic and Social Affairs (UNDESA) Capacity Building



national-level initiatives (UNDESA and UNDP, n.d.), the International Atomic Energy Agency (IAEA) technical cooperation (IAEA, 2017) and the UNDP Asia-Pacific CLEWs training (UNDP and UNDESA, 2021).

Nexus dialogues or short duration stakeholder workshops, identified with ‘B’ in Figure 9.1, frequently involve stakeholders from multiple sectors and organisations. Often stakeholders gather to discuss specific complex and cross-sectoral issues and implications. The aim is to foster and promote cooperation among different organisations in addressing such challenges. In this process, knowledge is transferred among actors and created if certain relationships have not been made before. Thus, this type of initiative, oriented towards developing nexus knowledge, operates at the level of interinstitutional cooperation. Examples of these activities include the United Nations Economic Commission for Europe (UNECE) transboundary nexus dialogues, FAO nexus dialogues or the stakeholder nexus workshops in the SIM4NEXUS project (Brouwer et al., 2020; FAO, 2020; UNECE, 2018a; UNECE, 2019).

Another important initiative that contributes to nexus learning, which enables nexus capacity development but is not structured as a capacity-development programme and learning is achieved informally, from an educational viewpoint. This category represents conferences, expert (or thematic) meetings and winter/summer schools, identified with ‘C’ in Figure 9.1, targeting a wider community but gathering experts that relate directly or partially to interdisciplinarity practices. Examples of such initiatives include the Annual Meetings of the Integrated Assessment Modeling Consortium (IAMC, 2020), the Nexus Project Cluster (Nexus Cluster, 2018), the Nexus Task Force meetings of UNECE (UNECE, 2016) and the Dresden Nexus conference (UNU-FLORES, 2019), to mention a few. Participation in conferences and meetings allows the dissemination of new knowledge and for the experience to be shared. Moreover, such initiatives can inspire further research and/or promote new conceptual relationships, approaches and applications. These can also result in the forging of new collaborations. Under this view, these activities target the ‘sector/network’ capacity levels and contribute to the ‘enabling environment’. Additionally, personal knowledge is also developed at the ‘individual’ level from participation in the conference or meeting. The improved capacity can directly affect the individual’s work or represent additional expertise that the expert can provide, increasing the expert’s skills portfolio.

Ideally, capacity-development interventions should consider the inter-relations between levels of capacity, effects and influences and at all entry levels. In integrated assessments or CLEWs-type analyses, such effort is critical to creating real opportunities to uptake the integrated approach to planning and decision making. Nexus knowledge created through practice is of great importance to the learning at all levels, and provide real-case examples and gap identification which can motivate new research. In sum, nexus knowledge intricately connects across the possible learning contexts and is reachable via all different learning types. Table 9.1 summarises the key points of this section by establishing the correspondence between approaches to learning, types of nexus and CLEWs knowledge-transfer activities, and the ‘capacity levels’ framework.

*Table 9.1 Nexus learning in the perspective of capacity levels, challenges to capacity development, learning approaches and knowledge-transfer activities*

<b>Level of capacity</b>	<b>Description</b>	<b>Type of capacities</b>	<b>Examples of challenges</b>	<b>Dominant type(s) of learning</b>	<b>Knowledge-transfer activities</b>
Individual	Skills, experience and knowledge vested in people (individuals) (UNDP, 2008).	Technical knowledge; inter and cross-disciplinary knowledge (other sectors); systems thinking.	Activities and projects which enable the use of new capacity. Skilled individuals leaving the organisation. Lack of access to training opportunities (e.g. time, funding and resources). Lack of infrastructure.	Formal, non-formal and informal	<ul style="list-style-type: none"> <li>• Courses and projects at academic and vocational education institutions</li> <li>• Summer schools</li> <li>• Capacity-building programmes</li> <li>• Credited courses</li> <li>• Webinars, online educational resources</li> <li>• Nexus dialogues</li> <li>• Summer schools</li> </ul>
Organisational	Refers to structures, processes and resources and management of issues with an organisation.	Internal policies, arrangements, procedures and frameworks that enable the use of individual capacities, integrated approach to planning, systems thinking.	Organisational culture. Mismatch of capacity-development programmes and organisational priorities and work plans.	Formal, non-formal and informal	<ul style="list-style-type: none"> <li>• Capacity-building programmes</li> <li>• Nexus dialogues</li> <li>• Conferences</li> <li>• Expert group meetings</li> <li>• Project dissemination workshops</li> </ul>
Sector/network	Coordination within and across sectors, and internal and external entities, for the development of coherent strategies and policies.	Policy coherence, strategies and programming frameworks, service delivery, cross-sectoral coordination, cross and interinstitutional collaboration, policy reform, etc.	Alliances and traditional organisational cultures. Competing organisational priorities. Lack of coordination among initiatives and projects. Lack of capacity.	Non-formal and informal	<ul style="list-style-type: none"> <li>• Nexus dialogues</li> <li>• Conferences</li> <li>• Expert group meetings</li> <li>• Project dissemination workshops</li> </ul>
Enabling environment	Broader system within which individuals and organisations function, which can be hampered or facilitated by it. It defines how organisations interact.	Policies, legislation, power relations and social norms, all of which govern mandates, priorities, models of operation and civic engagement across different parts of society (UNDP, 2008).	Power relations, social norms and values.	Informal	<ul style="list-style-type: none"> <li>• Nexus dialogues</li> <li>• Expert group meetings</li> <li>• Project dissemination workshops</li> </ul>

### 9.3 TRANSFERRING NEXUS KNOWLEDGE IN CLEWS-TYPE APPLICATIONS

The CLEWs framework has been used in several capacity-building programmes by a number of institutions (e.g. IAEA, UNDESA/UNDP, UNECA, UNECE, Royal Institute of Technology (KTH) in Sweden and Simon Fraser University in Canada). This section presents how knowledge transfer of the CLEWs framework has been accomplished over the past decade under different applications' formats (or categories). In the overview of the initiatives, we consider the aim, duration, type of activities, engagement of actors and how these link to the capacity levels.

The framework has been included in the course content of several undergraduate and graduate courses at KTH and motivated over 15 thesis projects (i.e. bachelor's, master's and doctoral level). The framework and its applications have also been featured in scientific conferences and/or presented at expert meetings. CLEWs training materials are available online as part of the outreach training course developed by UNDESA, UNDP and partners (UNDESA, 2016).

The examples highlighted in this section correspond to knowledge-transfer activities linked to the CLEWs framework. More specifically, we describe an example of activities A, B and C, which were mapped against the levels of capacity framework and are illustrated in Figure 9.1. These include an example of type A (capacity development in CLEWs), B (nexus dialogues and workshops) and C (conferences and meetings) activities.

#### 9.3.1 Example 1: Capacity-Development Programmes

The incorporation of CLEWs in capacity-development programmes started in the early 2010s in an effort led by the IAEA.<sup>3</sup> From 2015, the Economic Affairs and Policy Division of UNDESA (UNDESA-EAPD), in partnership with the UNDP, started including the approach in their capacity-building projects. We describe here this most recent format, which kicked off with the pilot cases of Nicaragua and Uganda (KTH-dESA, 2017; UNDESA-EAPD, 2016). The programmes built on previous UNDESA initiatives, where capacity building in energy systems and economy-wide models had been conducted or was ongoing (KTH-dESA, 2015; UNDESA-EAPD, 2015). In both cases, some of the participants in the CLEWs training already had background knowledge of the Open Source energy Modelling System (OSeMOSYS).<sup>4</sup> This modelling tool is currently used for the UNDESA/UNDP CLEWs capacity-development initiatives due to its versatility in terms of systems representation, for being open source and non-proprietary.

Capacity developed in the capacity-building workshops of UNDESA-EAPD/UNDP is mainly of individual and organisational-level types, with the dissemination of the project findings contributing to capacity development at the sectoral/network level. The training format is discussed with country-level institutional counterparts and largely coincides with the description in continuation. The programme's main purpose is to build capacity among an interministerial team of government officials to use quantitative tools in policy design. In the particular case of CLEWS, the aim is to promote the development and implementation of integrated planning approaches.

A complete UNDESA/UNDP CLEWs capacity-building programme typically lasts about 6–12 months, throughout which three to five one-week workshops are conducted. In the first workshop, general concepts are introduced related to the role of modelling to inform policy

or answer policy questions, the CLEWs framework, basics of the modelling tool to be used (i.e. OSeMOSYS). It is in this first week that participants explore the energy systems module default representation in the OSeMOSYS-CLEWs model and work for its improvement. Data requirements, availability and use are also discussed. Water and land systems are the second workshop's foci, where interlinkages between systems are identified and their representation is explored in the model. The third workshop is primarily dedicated to the improvement of the land systems' characterisation, as well as conducting further modelling refinements. The time between workshops is key for gathering data and preparation; hence, data availability and accessibility are common topics throughout the training. In the fourth workshop, interactions continue to be studied but from a perspective of scenario development to investigate policy questions identified throughout the workshop. Model limitations are also discussed, as well as data requirements for future model refinement. In this workshop, a plan is laid out for scenario studies and elaborating policy notes from the quantitative analysis. The latter will continue to be developed in collaboration with participants until the last workshop (fifth), when the policy notes are finalised and presented. Several stakeholders are involved/implicated in the capacity-development CLEWs programme. The national counterparts, particularly the institution that requests the United Nations' technical assistance and is responsible for coordinating the project at the national level and the participants<sup>5</sup> (i.e. government officials) take part in the several training workshops and in the intermediate activities between training sessions. Lastly, a dissemination workshop is held with policy-makers and high-level decision makers from the institutions who have sent participants for training and other invited institutions. It is also a common practice that government officials, who took part in the training, present their learning and the training outcomes within their respective institutions, extending further or creating opportunities for further knowledge dissemination and buy-in of the approach. Policy notes can be used to discuss particular topics of interest in interministerial meetings or cabinet meetings, for example. Throughout the training, efforts are made to ensure the analyses are the most relevant to pressing and current policy and development questions.

Model co-development may be possible, but it will likely be limited in terms of complexity (or it will be more straightforward) if different experts and stakeholders collaborate in the process (Voinov and Bousquet, 2010). A strong push exists for national ownership of the process, national modelling tools and the analysis – and this is the real issue. In particular, it can be hard to achieve within the timeframe of the activities and requires a continued effort and a strategic and integrated vision of the capacity-development initiatives. It is essential to build knowledge of the tool. It is also equally important to ensure the tools developed can answer relevant policy questions.

### 9.3.2 Example 2: Nexus Dialogues

Nexus dialogues, or stakeholder workshops, are a frequent stakeholder participatory approach used in nexus assessments. Such events also function as a means for nexus knowledge dissemination. Activities within this type of activity include short-term workshops (less than five days), which are part of a nexus assessment project. Depending on the scope of the dialogue, the audience can be quite diverse. In general, it is broad, including the public sector, private sector, non-governmental organisations, cross-country organisations, civil society and academic experts. The overall objective is to disseminate and advocate for specific topics, establish partnerships and collaboration and raise awareness. A certain degree of peer review and

discussion of ideas among peers is also present, as is the search for inputs from stakeholders, including the assessment of data availability. Thus, levels of capacity developed correspond predominantly to the organisational and network/sectoral levels. Capacity is also built at the individual level, from each participant's individual learning in the workshop. Such a capacity can transpire at the network level. Take the example of professional mobility by stakeholders who participated in the dialogue. As mobility will likely happen within a network, such stakeholders will take the nexus learning to their new institutions.

Nexus dialogues have a shorter-term duration (up to three days) and have a wide variety of stakeholders. Such dialogues could target a reasonably large number of participants (between 25 to 100) and also a factor of the number of institutions engaged and the number of countries sharing a basin or an aquifer system. Due to the time limitation and specificities that need to be accounted for, they tend to be rather short on the introduction to the nexus but include group sessions where participants are encouraged to engage in actual dialogues among themselves.

In the particular case of the Transboundary Nexus Assessment Methodology (de Strasser et al., 2016; UNECE, 2015), the events (or nexus dialogues) usually take two to three days and are spread out throughout the duration of the project. In each country, the project team and national counterparts aim to engage actors from the government (e.g. ministries and institutions related to the transboundary nexus systems) and regional organisations (e.g. river basin authorities, non-governmental organisations, private companies, academia, etc.). The dialogues aim to engage the same actors and/or institutions across all events organised under the same project. Workshop sessions vary from plenary discussions to group sessions. Group sessions are often mediated by facilitators who are part of the project team. The dialogues are held in specific stages of the project, described as follows.

A first dialogue follows from a desk study, which includes an initial analysis of the nexus context. When possible and as relevant, the systems are scrutinised in more detail on the area falling in the basin under study. This workshop aims to validate nexus interlinkages in the basin. It also informs on the central nexus (and country-level) challenges that affect the basin, and could be alleviated through transboundary cooperation. The analytical team uses inputs from the first workshop to build an analytical approach to investigate the challenges identified.

A second dialogue is held after the quantitative and qualitative analysis phase to discuss the outputs up to then. Stakeholders comment on the results and provide feedback on the analytical approach, which often requires an update of the analysis. Not all nexus challenges can be investigated (for several reasons, including the project's duration, number of experts involved, the expertise required, the specificity of the issues and capacity of modelling tools (or time to build or adapt the analysis), data availability and accessibility). Scenarios are usually discussed (and developed) between the first and second workshops.

A third dialogue is held at a later stage of the project. This serves to communicate the findings from the updated analytical approach and to discuss possible solutions. Inputs from the last workshop are used to further improve the study and agree and clarify the project outcomes and main messages. A draft report of the nexus assessment is usually available before the workshop and is to be discussed during the event. This provides an excellent opportunity to review the findings, further validate the assessment and identify critical issues that need to be addressed. The participatory approach establishes cohesion between the countries that agree on a collective message that is relevant at the regional and national levels. For knowledge transfer, this is critical as the final report will serve to disseminate the case study, the approach and the solutions found. The report can also play a role in developing capacity in the enabling

environment and motivate capacity development across organisations and/or at the individual level.

Nexus dialogues can go well beyond the analysis of nexus issues. In the experience of UNECE, for example, nexus dialogues become more and more focused on the joint elaboration of integrated (policy and technical) solutions (UNECE, 2020). They are also a way to discuss past experiences of implementing similar solutions in different countries – an important occasion for knowledge sharing and peer-to-peer capacity building.

### 9.3.3 Example 3: Summer Schools

Nexus-themed summer schools are examples of knowledge-transfer activities that are not linked to a particular project, unlike the previous examples, with participation motivated by (strategic) individual interest. Capacity and skills are developed mainly at the individual level, although the school's purpose can expand towards the organisational level. Summer or winter schools are formal learning activities. They are structured and goal-oriented, require facilitators or trainers, happen in a specific timeframe and are accredited or certified.

CLEWs summer schools have been held in the International Centre for Theoretical Physics and other institutions throughout the 2010s. The first schools were held over one week and focused on stock-taking CLEWs examples, modelling tools and quantitative approaches, and discussing policy coherence (ICTP and IAEA, 2012, 2013). Later in 2017 and 2018, learning and teaching activities expanded to three and four weeks, respectively (ICTP, 2017, 2018, 2019; OpTIMUS Community, 2019). In the latter events, audiences and scope were slightly different from those in the two previous schools. In 2017, the emphasis was on developing integrated CLEWs models using a single tool (OSeMOSYS). Country-level multi-disciplinary teams of government officials participated and developed the models. UNDESA and UNDP funded their participation. The 2021 edition (ICTP, 2021) and the UNDP Asia-Pacific training (UNDP and UNDESA, 2021) follow a similar approach, except these initiatives are organised in an online format. In 2018 and 2019, most participants were self-funded, and their work sector was more diverse, though academia was dominantly represented. The purpose of the 2018 summer school was to build and develop knowledge on the use of OSeMOSYS to build energy systems models. However, in this school's edition, participants also learned how to use the modelling framework to represent water, land and climate systems. Common to all editions were knowledge transfer in scenario development and the investigation of policy, technological or resource-management questions. The 2017 edition targeted the development of individual and organisational capacity, as participants came from governmental institutions; whereas, in 2018 and 2019, the strengthening of capacity was promoted as a relatively recent field.

In terms of learning activities of the latest format of the International Centre for Theoretical Physics summer schools, the school's first week was dedicated to introducing general contents of energy systems analysis, planning and modelling, with a brief introduction to the CLEWs framework. In the second week, participants explored how to use OSeMOSYS to represent water, land and climate system elements. In the last week(s), sessions were dedicated to improving country models, developing scenarios and analysing results. The school activities closed with individual or group presentations of the analyses performed throughout the training and poster sessions. Although the primary learning approach was formal in this setting,

participants also had the opportunity to learn from their peers, contextual challenges and analyses approach and the unfolding discussions.

In some cases, the knowledge transfer enabled the initiation of teaching activities led by participants in their respective country-universities, such as the University of Sierra Leone and Makerere University in Uganda. Additionally, participants' new technical-analysis capacity and the consequent reporting at their respective institutions supported the dissemination of the integrated approach and its potential use to inform decision making. The increased interest has facilitated the request for specific in-country technical assistance from international organisations.

## 9.4 KNOWLEDGE TRANSFER IN THE TRANSITION TO AN INTEGRATED PLANNING APPROACH

Due to its multi-disciplinary dimension, the nexus methodology is continuously evolving and changing. Community efforts exist to create knowledge-sharing opportunities (e.g. conferences, meetings, CoPs, academic journals' special issues and research topics), engage public and private decision-makers or incorporate the nexus approach content in academic studies. This dynamic mobilisation and creation of nexus knowledge happen organically, many times shaped by the assessment necessities. Knowledge transfer is continually occurring between those involved in the assessment, independently of their involvement level and work area. In this process of nexus knowledge transfer, which aims to solve complex multi-systems challenges, one may find conditions that support the study's development (and future applications) and the uptake of the integrated approach, and opportunities not foreseen initially. In this section, we highlight enabling conditions and opportunities that could support the knowledge-transfer process, and consequently, contribute to successful nexus assessments. Also discussed are aspects that can manifest as barriers and challenges to nexus knowledge transfer, for which we indicate possible strategies to overcome them. In this analysis, 'challenges' differ from 'barriers' as they do not necessarily impede the knowledge transfer but can delay or compromise it. Barriers are interpreted to be more practical aspects that could be overtaken. Key aspects are listed in Table 9.2.

### 9.4.1 Barriers

The 'barriers' described in this section refer to obstacles that impede or prevent nexus learning and, consequently, successful nexus applications or the transference of the approach. They are more practical and relate to management and resources issues. The barriers indicated in Table 9.2 are described here.

A common barrier to knowledge transfer is *access to learning materials*, including the stock-taking of practical examples. These resources can assist the knowledge-transfer process occurring in the different stages of a nexus assessment and the learning and teaching activities at the academic level. Moreover, they are critical elements for developing nexus-oriented capacity-development programmes, either for formal learning processes or to increase non-formal learning opportunities in contexts where information is not within reach of the learner. Coupled with CoP initiatives, we find an opportunity in the obstacle for the development of joint resources that can be disseminated to wider audiences (and made available in

*Table 9.2 Overview of enablers, opportunities, barriers and challenges in transferring nexus knowledge*

Barriers	Challenges
Access to learning materials and compilation of (practical) case study examples	Siloed thinking Unused capacity
Policy mandates and cycles	Sustain capacity
Data access, availability and retrievability	Experts' professional mobility
Limited availability of resources (e.g. human, infrastructure)	Continued stakeholder engagement and uptake of the integrative approach
Individual beliefs and values	Assumptions of what is known Effective knowledge dissemination Monitoring and evaluation of an integrated approach
Enablers	Opportunities
Assessment of learning and capacity needs	Participatory processes
Formal learning processes	National and international development agendas
Levels of capacity framework	Curricula development for the nexus in support of sustainable development
Recognition, validation and accreditation	Development of modelling tools and methods
Transfer/exchange of expert knowledge and communities of practice	Policy learning
Partnerships and collaboration	Strengthening of the policy-science-society interface
Institutionalisation of interdisciplinary thinking and practices	Long-term knowledge and data collected by local experts

different languages). In this way, resources can be peer-reviewed, validated and improved by a community of experts and practitioners. Compilation efforts of applications and respective descriptions, including contact information, are increasing and can support the development of materials and their tailoring to specific contexts. Examples include the Nexus Platform knowledge Hub, managed by the German Corporation for International Cooperation (GIZ, 2016), and the Penn State WEF-Nexus strategic initiative (Arenas et al., 2021).

*Policy mandates and cycles* define and shape the use and management of resources and activities in the nexus systems. Also, investment decisions have medium- to long-term implications to the nexus context and external factors to decisions, such as consumer behaviour. The update of policies already in place, and linked regulations, could turn into a complicated process. Nexus assessment recommendations may not be implementable in the shorter term and, along with the multi-systems dimension, their implementation is challenging. The transition is even more cumbersome if interdisciplinary skills and technical capacities are missing. Even when capacity exists, required modifications at the governmental and decision levels can delay or block the integrated approach's adoption. Suppose the stakeholders involved are not familiar with the concepts, or there is a lack of ownership. In that case, the assessment outcomes may be limited, and the transposition to policy narrows. Alternatively, if newer team members or the leadership are familiar with the nexus concept, the integrated approach is more likely to benefit from continued support. The enabling environment and organisation-level capacity are vital in overcoming challenges faced by policy cycles.

*Data access, availability and retrievability* are known barriers to the development of nexus assessments. The lack of data or difficulties accessing it can affect the level of detail of a study, the coverage of nexus systems, provide limited insights from the quantitative analysis and ultimately affect the trust-building process with stakeholders. These limitations pose a challenge to prospective knowledge transfer and creation compared to the case in which the



data context was different. Capacity-development programmes could help overcome the data gap by including data-intensive cases in the training programme. In this way, the learning process promotes and underlines the importance of data availability. Open-access datasets and databases are increasingly common and provide information at the multi-system level (FAO, 2012, n.d.; JMP (WHO, UNICEF), 2017; NASA, 2019; Pekel et al., 2016; UNSD, n.d.; World Bank, 2017). Their use requires expertise and capacity that might need to be developed, not to mention physical infrastructure (e.g. computers, internet access). Although limitations to the use of open data may exist, these can be good starting points for analyses characterised by data constraints.

Another barrier to knowledge transfer is the *limited availability of human and infrastructure resources*. We distinguish this barrier from limited access to educational resource materials due to its dependence on the local context, where it is necessary to develop capacity. This barrier highlights the importance of developing, expanding and maintaining local capacity (Ubels et al., 2010) to continue learning, applying and developing the new knowledge, and transferring it to other local authors. It is also essential to provide adequate infrastructure (e.g. computers, internet connection, reliable electricity supply, equipped rooms or buildings).

*Individual beliefs and values* influence the decision-making process. They also affect the dynamics in the science–policy interface, especially when considering the number and diversity of actors involved and the complexity of the problems investigated. If knowledge for the nexus approach is non-existing or lacking, stakeholder engagement and participation are more challenging to establish. Another barrier is the potential lack of receptivity to the evidence-based decision-making approach, which can further complicate the adoption of the nexus approach. Overcoming this barrier requires the reconstruction of existing knowledge and learning and teaching strategies adapted to this challenge. The Challenge-and-Reconstruct Learning Framework proposed by Smajgl and Ward (2013) could be helpful in this context. Integrating nexus knowledge learning at academic and vocational education institutions can gradually broaden perspectives on the integrated approach.

## 9.4.2 Challenges

‘Challenges’ correspond to pre-existing conditions or new circumstances that can disturb the knowledge-transfer process. Here we briefly describe the challenges listed in Table 9.2.

The first is the *siloeled approach* in planning, referring to the planning and management of sectors dominantly from the perspective of the services provided (e.g. energy sector plans). Although this approach is necessary for the operation and functioning of sub-sectors, strategies and overarching plans benefit from the integrated nexus approach. Resource allocation and policy design can be performed from a cross-sectoral point of view, avoiding the elaboration of counterproductive plans and decisions. Understanding the advantages and disadvantages of the approaches and their applicability is linked to the organisational, network and enabling environment capacity levels.

A challenge in CLEWs capacity development relates to building capacity and *capacity not being used* (UNDP, 2008). If capacity developed is not mobilised or cross-linked to the organisation’s existing knowledge and activities, it should not be expected to improve performance and circumstances. Incentives, resources and work plans should accommodate the capacity developed, assuming the development programme is based on capacity ‘needs’ assessment. A capacity-development vision is designed with goals and priorities. It builds on a plan for

capacity development, which considers the capacity levels and supports overcoming unused capacity challenges. Coordination is required between institutions involved to promote and conduct such activities – an effort susceptible to obstacles. Vested interests, power dynamics and preconceptions on the capacity-development aims exist both internally and in external partners. Countries have a history of capacity-building activities performed under different formats and targeting different levels (individual, organisational, sector/network level, enabling environment). The long-term vision of capacity development requires an assessment of capacity developed at these different levels and an exercise of identifying the cross-level added value of such activities. The latter could then identify the needs for capacity development, which would benefit all levels comprehensively and soundly if adequately addressed. Sustaining capacity is also a challenge in the academic context, especially when funding is lacking to pursue nexus research or contrasting research priorities exist.

*Sustaining capacity* and capacity-development activities is a complex challenge that links to many aspects referred to in this section: availability of resources (educational, human or infrastructure), the uncertainty generated by policy mandates, the inflexibility of policy cycles, unrooted development of capacity and reconstruction of learning. Thus, to address this challenge, action needs to be taken at different levels. A sound and integrated capacity-development strategy tackles issues related to the development of expertise and professionalisation. Moreover, it ensures that the capacity developed is the capacity needed and not dictated by ongoing trends (Ubels et al., 2010).

*Experts' professional mobility* and transition can be a downside, or even a rebound effect, of capacity development. Trained professionals tend to transition to different job positions, usually higher in the hierarchy level, due to improved expertise and skills. If not accounted for in the capacity-development plan (e.g. including several trainees from the same department) and effectively accommodating the use of the capacity in the work plan, capacity built ends up not remaining in the organisation, hampering the goal of strengthened institutions. Also, including the development of nexus-related capacity and skills in the professional development plan can work as an incentive for professionals to more actively engage in the activities while creating options for transition within the organisation or institution.

Along with sustained capacity development at the organisation or institutional level, *continued stakeholder engagement and uptake of the integrative approach* is another challenge when incorporating the nexus approach. Transferring knowledge and sharing experiences across actors and sectors is critical for its implementation, consolidation and continued improvement (Miralles-Wilhelm, 2016). Nexus practitioners must ensure that, when nexus knowledge is transferred, it includes information relevant to the stakeholders. Besides, an environment of knowledge sharing among stakeholders must be fostered (within the nexus application conditions) and their contribution recognised by the organisation. In the context of stakeholder participation, actors involved in the assessment will need to handle the confronting relationship between flexibility and learning (perspective of research and the result-oriented approach, needed by decision-makers) (Ubels et al., 2010).

Also related to stakeholder participation, but relevant to collaboration between all actors within nexus assessments, are the *assumptions one (or a team) makes of what others may or may not know*. This challenge can be reduced by planning capacity-development activities based on capacity needs assessments, improving communication methods and tools (Clarke et al., 2008) and evaluating and reassessing participatory events or other group interactions. Also, providing and sharing appropriate and concise reading materials (literature) before events is

advantageous for levelling base knowledge and clarifying terminology. Nexus-related educational resources and a nexus case inventory can be used if available.

Ensuring *effective knowledge dissemination* to the diverse audience of nexus assessments, nexus research or less experienced practitioners is another challenge that requires attention. In a nexus assessment, consultation with stakeholders will always involve a learning experience. Different strategies are used to introduce systems thinking and understand the implications of sectoral decisions on other systems. In the UNECE nexus assessments, group interactions are implemented, with stakeholders grouped following different criteria in the separate workshop group discussion sessions. Groups then present their findings and analysis to the whole group. In the Integrated Solutions for Water, Energy and Land project (IIASA, 2019), a board game was developed for stakeholder nexus dialogues. Application of serious games to nexus cases (Brouwer et al., 2020) is another emerging strategy used to teach the nexus concept to stakeholders, groups of interest and academic and vocational education contexts. More and more, visualisation platforms are built to present results from nexus assessments. Some are used for education and training (Centre for Systems Solutions, 2018; UNDESA and UNDP, 2016). Others are case-specific and are used in nexus dialogues for scenario development (IIASA, 2018) or developed to present and discuss modelling results (Ramirez Gomez et al., 2020a, 2020b). More general types are visualisation dashboards for water-energy-food nexus indicators (Simpson et al., 2020) or for producing visualisations from integrated assessment model results (Gidden and Huppmann, 2019).

Another challenge is the *monitoring and evaluation* of the benefits of following an integrated approach to planning and policy-making. This gap is identified by Hicks et al. (2010), who examined interdisciplinary approaches in environmental sciences to understand their implications, both at the level of specific subjects and as enablers for systematic and expanded practices. In the nexus approach, such a gap translates into a lack of solution implementation examples, which have been informed by nexus assessments or suggested by research. Evidence on the performance of nexus solutions is required for the uptake and advancement of the approach.

### 9.4.3 Enablers

By ‘enablers’, we refer to existing methods, mechanisms and conditions or circumstances that already exist and that can be deployed, leveraged upon or expanded in the context of the nexus practice and applications. The enablers indicated in Table 9.2 are described in order.

The *assessment of learning* needs is a common practice in capacity-development programmes. It is often a requirement when planning a nexus-related project, in particular when planning formal learning activities (i.e. courses, curricula, workshops and training). Applied to the nexus, such an approach requires a multi-systems perspective. Basic knowledge of how nexus studies can be conducted (i.e. nexus frameworks) is critical to this stage and can identify opportunities to mobilise existing expertise.

Effective nexus learning could benefit from understanding how best to conceptually organise and teach the topic. A *formal learning process* could support this effort. The endeavour can be more challenging when facilitators are less familiar with a specific dimension of the nexus. Thus, the learning and teaching should be designed considering the transdisciplinarity of the fields and the facilitators involved. It would be necessary to have a repository of methods and educational resources available or to be developed. The knowledge bank could include struc-

tured educational resources, training materials, clarification on terminology, a compilation of initiatives and practical examples and course literature. All should be organised in terms of level, topic and an indication of the intended learning objectives. A similar approach can be followed for the planning of capacity-development events. In this case, formal learning activities would be related to the project context and aim, institutions involved and learning objectives.

Critical for capacity development in the nexus is a sound understanding of the implications of the capacity developed across all its levels (i.e. individual, organisational, sector/network and enabling environment). The use of the *levels of capacity framework* can support nexus practitioners involved in knowledge transfer in planning robust and adequately framed training activities within all capacity levels. Besides, its adoption could strengthen the links between local-, regional- and national-level policies and programmes (Ubels et al., 2010). Planners need to ensure that the learning (or capacity) needs, the capacity-level entry points and the training characteristics (e.g. activities and contents) are compatible and feasible to implement in achieving the overall learning objectives. The proposed comprehensive and integrated approach could result in capacity expansion within institutions (transversally) via in-house knowledge-transfer events, which has happened in the national CLEWs studies of Nicaragua and Costa Rica. Another benefit of the approach is its incorporation in work plans, creating multi-institutional teams or committees, and including nexus capacity in the professional development plan.

When included in all academic and vocational education programmes, nexus-dedicated courses (or where it has been included as content) already contemplate learning accreditation. The application of *recognition, validation and accreditation* to informal and non-formal education is not as straightforward due to the learning approach's nature. However, it is important that the learning can be acknowledged and the individual (and the organisations facilitating the learning process) can formalise the knowledge transfer. Educational and socioeconomic contexts vary worldwide, and the general learning approach can differ significantly (e.g. North–South) (Singh, 2015). The implementation of recognition, validation and accreditation could synergistically benefit the integration of capacity-development levels when planning capacity-development activities, assist or feed on the capacity assessment or individuals in an organisation and contribute to better learning activities. It could also provide experts with developing knowledge through informal and non-formal methods to have their knowledge and skills recognised and made comparable. The latter is particularly relevant to the next point (although not a determinant) and the development of pools of nexus experts.

With *experts involved in nexus assessments*, the iterative learning process refines their skills, both in terms of quantity (e.g. more examples and cases) and quality (e.g. results analysis, interaction with stakeholders, exploring alternative solutions). Combined, this leads to knowledge that is not easy to transfer yet significantly contributes to the nexus practice's advancement across all project stages (including planning and implementation). CoPs, as practitioner networks, enable some of the knowledge to be transferred. Such communities also encourage exchanges between various stakeholders, such as modelling tools (Miralles-Wilhelm, 2016). Additionally, CoPs create a space for discussion of all aspects in analysis, from methodological steps, modelling tools and approaches, findings, etc. However, CoPs are characterised by specific expert networks and information permeating out of these groups is not always easily accessible.

Transfer of expert knowledge could be facilitated by establishing pools of practitioners, interactions between CoPs and developing a knowledge bank of case studies linked to the respective contact person(s). In formal education processes, interdisciplinarity should be introduced early in the curricula for this skill to be embedded in future professionals' education. Another aspect of this enabling condition is its prospect of establishing support services for capacity development (Ubels et al., 2010).

*Partnerships and collaborations* enable capacity development and capacity transfer between the sides of the 'partnership'. When different sectors and levels of decision are involved, transdisciplinarity is achieved, which is crucial for solving complex problems. For balanced collaborations, partners need to consider the political and ideological preconceptions brought to the table that may influence the dynamics of the relationships, negotiations and decisions — such influence can ultimately enable or hinder effective collaboration and learning opportunities. External organisations (international organisations) can play an important role as facilitators for active and long-lasting partnerships (UNDP, 2008) and in reaching compromises that involve questions of power and politics (Ubels et al., 2010). Although 'partnerships and collaborations' are identified here as enablers, they can also be regarded as opportunities through the establishment of new contacts or mobilisation of expertise in new assessments and/or research activities.

Another enabler to knowledge transfer is the *institutionalisation of interdisciplinary thinking and practices*. Incorporating interdisciplinarity in organisations requires officials to develop capacity on the topic, promote collaboration across institutions and sectors and promote exchange within the policy–science interface (Miralles-Wilhelm, 2016). Additionally, the sectoral expert knowledge residing in each institution will be mobilised and poured through other areas of work, structures and working cultures. Such contribution could confer credibility to the project or assessment by building the necessary buy-in and trust required to successfully apply the nexus approach in decision making (Ubels et al., 2010). Integrating interdisciplinarity across and between institutions could come with challenges related to communication between different actors and overwhelming expectations for finding integrated solutions when nexus capacity is still under development. The establishment of interinstitutional (and transparent) databases, through which nexus systems and related information would be accessible, contributes to meeting this challenge.

#### 9.4.4 Opportunities

As 'opportunities', we consider existing aspects or sets of conditions that can facilitate or assimilate knowledge-transfer activities. The enhancement of such elements can improve learning and implementation. Here we describe the opportunities listed in Table 9.2.

*Participatory methods and approaches*, including in the nexus, are widely covered in the literature. These include, for example, nexus dialogues and scenario developments (Bazilian et al., 2012; Graham et al., 2018; Kok et al., 2006; Martinez et al., 2018; Mohtar and Daher, 2016; Parkinson et al., 2018; Wada et al., 2019), group modelling exercises and engagement (Smajgl, 2010; Voinov and Bousquet, 2010) and others. Participatory processes are vital for nexus studies' success when the aim is to inform policy- and decision making. In terms of knowledge transfer, they are unique opportunities to disseminate nexus knowledge to individuals and organisations. They support building networks, collaboration and partnerships and, notably, they ensure significance to the study and its outcomes. Stakeholders are the entry

point of the nexus science to policy and practical applications of the nexus approach. There are, however, several challenges in this process that should be accounted for: the engagement of relevant actors; the diversity of stakeholders involved and their continued involvement (Lundgren and McMakin, 2009; Smajgl and Ward, 2013); the reconciliation of interests; and trust-building (Smajgl and Ward, 2013), to name a few.

The momentum created by *national and international development agendas* can play a part in disseminating the nexus approach, increasing the opportunities for nexus knowledge transfer in various contexts. Concern over the integrated sustainable development and policy coherence are important entry points for the nexus approach. The analysis of impacts, trade-offs, opportunities and synergies is a common element of CLEW assessments. This requires understanding how systems and sectors operate and how they affect or are affected by other systems. Stakeholders involved in nexus assessments are required to see their sector's interests and ambitions from other sectors' perspectives. As an outcome, integrated and coherent policies and strategies can be produced. The 2030 Agenda and the Paris Agreement are excellent examples of the drive that international agendas can proportionate to advance the nexus approach and all the associated learning.

The expertise built over participatory processes and lessons learned in nexus assessments are much-needed examples for continued uptake of the nexus approach and important content for *curricula development* in formal education contexts. The advancement of teaching about the nexus can then retro-feed participatory processes, support dissemination and sharing of experiences and contribute to new research ideas. From a teaching perspective, it aids the production of versatile educational resources and the testing and development of teaching methods best aligned with the nexus approach. Also, it strengthens the nexus research and the production of scientific literature, which contributes to knowledge transfer and the education and training of future nexus practitioners and stakeholders.

The nexus challenges how to investigate case studies, including policy ambitions, 'resource' use contexts, knowledge exchange and interactions with stakeholders. They all contribute to the *development of modelling tools and new methods* for the nexus. Knowledge creation at this level includes, for example, the fast diffusion of open-source tools; new communication techniques for making systems thinking easier and more accessible; and data visualisation, of which geospatially explicit data are an emblematic example. Data availability and accessibility, as well as the tools and expertise available, shape the quantitative approach. Not all methods are transferable, and understanding limitations is vital. This is only achievable if knowledge is shared. Developing tools that are easily transferable and applicable in various contexts would certainly support the uptake of the nexus approach in practice. The integrated modelling framework for CLEWs developed in OSeMOSYS and used for capacity development by UNDESA and the UNDP is an example of the transference of methods. While nexus knowledge is used, it is also continuously advanced. Simultaneously, the science-policy interface is strengthened.

Workshops, training and meetings in which nexus issues and analyses are discussed are great *policy-learning* opportunities for decision and policy-makers and other stakeholders involved in the process. Stakeholder participation throughout the development of a nexus assessment, or even on fewer occasions, can result in knowledge expansion and multi-disciplinary thinking, which decision-makers can tacitly embed in their practice. In the particular case of public policy, nexus-related learning can stem from the implicit iterative learning process through policy evaluation (Howlett and Ramesh, 1995). This includes discussing solutions to

cross-sectoral issues and how these can be addressed in practical terms, and the type of instruments that could support the new strategies.

Activities involving and promoting information exchange between different stakeholders in a spectrum of sectors contribute to *strengthening the policy-science-society interface*. On the one hand, cross-sectoral issues are discussed, and their causal links, impacts, propagation mechanisms and feedback loops identified. Practitioners and stakeholders learn throughout this process of identifying and characterising complex problems, which can lead to innovative solutions of coordinated actions that benefit the nexus context over time. On the other hand, the actors involved improve their understanding of how other fields of work function, how different organisations are structured and operate and how decisions at the various levels are taken. Learning at this level can happen through lesson-drawing (or endogenously) from formal decision processes; or via social learning (exogenously) from other applications external, yet relevant, to the policy context (Howlett and Ramesh, 1995).

*Long-term knowledge transfer* at the local level creates opportunities for accessing and retrieving data in a timely relevant manner for a study with the involvement of (or by) local experts. Additionally, it can expand and improve data systems for integrated analyses (e.g. measuring and monitoring systems). This aspect can also function as an ‘enabler’ due to the potential compounded effect of existing knowledge leveraging nexus assessments and adopting the approach in decision making.

## 9.5 CONCLUSIONS

This chapter provides new and senior practitioners information for the planning and implementation of learning activities embedded in nexus assessments. It also considers the role of learning activities in the context in which they are implemented and the target audience involved (e.g. academic and vocational education, business, public sector, civil society). We describe and compare examples of CLEWs-type applications from the perspective of knowledge transfer. However, we acknowledge that other nexus frameworks also contemplate similar knowledge-transfer activities using various methods and tools. This chapter aimed not to compare approaches but to identify the role of learning and observe how it is differently accounted for in studies with diverse aims and designs. It also serves as a means to transfer this type of experience within and beyond the nexus community. In this manner, nexus practitioners and approach advocates, interested people and people of interest are informed about how knowledge is shared, created and developed in a nexus assessment process.

The nexus approach is about integration and multi-disciplinarity and making wide-ranging, coherent and sustainable development-aligned decisions. It is yet to become mainstream, and continuous learning is required in the process. It holds the immense potential of facilitating communication and promoting collaboration across sectors and departmental divides, ultimately leading to the incorporation of nexus thinking in policy design. Learning processes can support its advancement and uptake by policy-makers. Entry points for knowledge transfer include academic and vocational education programmes, capacity development or participation in CoPs, to name a few. Thus, all aspects involved in adopting the approach should equally consider multiple dimensions in support of robust and effective decision-making processes in any timeframe.

Barriers, challenges, enabling factors and opportunities to knowledge-transfer processes in the nexus studies were identified and described, particularly regarding applications of the CLEWs framework and related examples. Key barriers and challenges identified include (1) comprehensive planning and development of capacity taking into account existing capacity; (2) implications across the levels of capacity (individual, organisation, sector/network and enabling environment); (3) the existence of the necessary resources to support knowledge transfer (educational, human, infrastructure) and (4) how to develop and sustain capacity at the local level. As key enabling factors and opportunities, we found (1) the vast number of applications that can be transferred from practice to all academic and vocational programmes; (2) ongoing nexus practice knowledge sharing through different CoPs, collaborations and partnerships (knowledge sharing is highly beneficial for advancing the approach, which, coupled with participatory processes, can fasten the transition to integrated planning approaches); and (3) regarding professional learning and capacity development, considering the interrelations between levels of capacity, effects and influences at all entry levels.

In summary, enablers, opportunities, barriers and challenges are interrelated. Acting over, addressing or improving one aspect could benefit another element, and practitioners should be aware and reflect upon the connections and respective implications. We highlight the importance of integration and a holistic approach to designing and planning learning activities in the nexus context, regardless of the learning setting. This effort should include a reflection on the learning methods that can be developed and deployed appropriately to ensure the success of the knowledge-building processes. Aspects such as the audience, the specificities of the project or study or the long-term influence of the learning should be considered in the design and transference of materials and resources related to nexus activities (extrapolating from CLEWs-type assessment experiences and other existing practices). Knowledge transfer can advance the nexus approach not only in academia and research but also in practice. Framing the knowledge-transfer activities in terms of capacity levels, which considers existing capacity and a needs assessment, could be the way forward in planning and developing capacity-development programmes. An example could be establishing institutional arrangements that facilitate the continued use and improvement of the skills developed, including the incorporation in work programmes. Such a strategy would put the knowledge to use and consolidate the nexus approach within decision environments. Building local capacity, and supporting it with a strategic and longer-term plan, would ensure the sustainability of the nexus approach via the science–policy interface. Such experience would then retrofit into the nexus knowledge transferred in the different learning contexts. Importantly, opportunities for interdisciplinarity should also be encouraged among practitioners (academia, research, policy-makers, and other stakeholders) to support science-based evidence entering policy- and decision-making processes and vice versa.

## NOTES

1. This chapter is available for free as Open Access from the individual product page at [www.elgaronline.com](http://www.elgaronline.com) under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (<https://creativecommons.org/licenses/by-sa/4.0/>) license.
2. The 2030 Agenda for Sustainable Development is the universal action plan launched by the United Nations in 2015 that builds on the previous agenda defined by the Millennium Development Goals. The new agenda is structured around 17 Sustainable Development Goals and their 169 targets.



3. By 2012, CLEWs analyses were being conducted in several countries and imparted by the International Atomic Energy Agency (UNDESA, 2014). Countries involved in the initiative included Brazil, Germany, India, Lithuania, Mauritius, Thailand, South Africa and Syria (UNDESA, 2014). These consisted of quantitative analyses of issues related to the CLEWs nexus using different sets of modelling tools. The analytical approach was strongly based on the soft linking of sectoral models (e.g. Low Emissions Analysis Platform, Model for Energy Supply Systems and Their General Environmental Impact and/or Model for Analysis of Energy Demand, Water Evaluation and Planning Tool, Model for the Analysis of Water Demand, Agroecological Zoning and Cropwat for water, land and agriculture and Computable General Equilibrium for the economy; some of the countries used their in-country developed tools).
4. Description of OSeMOSYS is an open-source linear optimisation modelling tool typically used for energy systems analysis (Howells et al., 2011). It has been applied in the development of CLEW-type studies, both through soft linking of sectoral models (Almulla et al., 2018; Ramos et al., 2017; Sridharan et al., 2019) and the integrated representation of CLEW systems (Alfstad et al., 2016; Balderrama et al., 2019; Sridharan et al., 2020).
5. The governmental officials from institutions that relate to sectors operating the dimensions of climate, land, energy and water, including central banks and the Ministry of Planning, Finance and Commerce.

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