Scientific knowledge integration and interdisciplinary collaboration:

Examining collaboration in EU project Globaqua

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Abstract

The paper investigates knowledge integration among researchers in the case of Globaqua. The theoretical discussion starts with interdisciplinary research (IDR). Different forms of disciplinary collaboration are dispersed, ranging from the least to the highest form of integration. IDR is about scholars trying to strive for active synergy of theories, frameworks and knowledge. Integrative understanding is a constituting element of IDR, coming to a shared understanding of an empirical phenomenon, is used to assess to what extent scholars in Globaqua achieved collaboration. Assessing the degree of dialogue and trust throughout the project is examined by researching into informal and formal interaction. Both concepts rely on relationship building as an incremental process, dialogue is thinking in relationship with one another and trust revolves around expected behaviour based on previous research endeavours. The paper explores knowledge integration by using a multimethod approach in threefold. First, interviews with researchers of the Sava RB sampling campaign which serves as a case study. Additional interviews with module leaders are incorporated to acquire a global image of Globaqua. Second, questionnaire data used to assess knowledge integration in Globaqua is explored. Third, the author developed an analytical tool to assess journal output produced in Globaqua. Analysing an aggregate of Globaqua articles done to overcome self-rating biases and explore a new vantage point to assess IDR. The paper argues that differences in the degree of knowledge integration persist throughout the project. It is shown that the Sava RB sampling campaign fostered further integration between chemistry and biology. Integrative understanding is hampered by lack of active managerial steering on aligning theories, frameworks and knowledge. Informal interaction is assessed by using the Sava RB sampling campaign as an example. The formal interaction is assessed by examining project meetings. It is shown that project meetings were valued in a different way. The paper concludes that knowledge integration in Globaqua is layered, as some collaborations were more successful than others. Recommendations to overcome the lack of alignment and to assess IDR in the future are presented.

Keywords: Interdisciplinary research (IDR), Knowledge integration, Integrative understanding, Dialogue, Trust.

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1. Introduction

Human well-being and other life on earth are dependent on the availability of (fresh) water. Rivers are a vital aspect to supply in this constant demand for water. Recently large cities had to ration water due to water scarcity. In the summer of 2017 eleven Italian regions were in a state of emergency due to the shortage in water (BBC, 2017). Fresh water shortage and extreme draught are just some of the factors influencing rivers. Water scarcity isn't solemnly caused by climatic factors, in many regions the water consumption is much higher than the water availability. A variety of stressors can pose a threat throughout Europe. It is likely that water scarcity will increase in the near future due to abstraction and climate change (Navarro-Ortega et al. 2014). The whole river ecosystem is affected by a multitude of stressors: both organic- and inorganic pollution, geomorphological alterations, water consumption, invasive species and more. Globaqua is a project funded by the EU that strives to assess this multitude of stressors and combines insights from various disciplines including, chemists, biologists, economists, sociologists and experts in knowledge brokering and policy advocacy (Navarra-Ortega et al. 2014). Within Globaqua assesses the effects of water scarcity by focusing on six contrasting river basins including the Ebro, Adige, Sava, Evrotas, Anglian and Sous Massa. What these river basins have in common is that water scarcity is a present or potential issue (Globaqua, 2015). The project started in February 2014 and is scheduled until January 2019. Three different strategies are combined in Globaqua: descriptive field campaigns, controlled field experiments, and manipulative experiments in the laboratory and in artificial streams (Navarro-Ortega et al. 2014).

The aim throughout Globaqua is to research interactions and linkages between stressors to provide guidance for water management and policies. Stressors are interrelated and should be examined in a cohesive manner. A change from water management to river basin management has occurred to incorporate standardisation (Slob et al. 2016). River basin management is focussed on an integrated approach, both ecological- and human activity will be monitored. Integrating approaches asks for the so called collaborative knowledge production (Slob & Duijn, 2014). Joint- construction of policies, defining problems and bringing stakeholders together is required to provide a holistic view on river basin management (Slob et al. 2016). In other words, river basin management requires knowledge integration which involves more profound cooperation between research disciplines.

Structuring knowledge was predominantly done through the lens of disciplinary specialization during the twentieth century (Klein, 2017). Specialized domains were classified within a larger framework incorporating discrete categories. Disciplinary structure of science is inherited from nineteenth and twentieth century political organization (Wagner et al. 2011). The idea of structuring disciplines through categorisation dates back to Greek influences by Plato and Aristotle.

What first proved effective later became a handicap, knowledge was fragmented as science grew: too much information for a single person to handle was spread across disciplines (Ledford, 2015). In the last half of the 20th century interdisciplinary activity increased and was usually categorised along the lines of group related activities (Klein, 2017). These categories were labelled by technical terms and organised around large projects such as the Organization for Economic Cooperation and Development (OECD).

To account for knowledge integration Interdisciplinary Research (IDR) approaches are used. Interdisciplinarity is a restructuring of knowledge which opts for a more holistic perspective than traditional divisions of knowledge do (Klein, 1990; 2008; 2017). One of the core objectives to engage in interdisciplinary research is solving complex- and so called 'wicked problem', problems which go beyond the reach of mono-centric approaches and are averse to easy solutions (van Meerkerk & Slob, 2013). IDR brings together universities, different departments, research teams and enhance knowledge integration when working on a joint project (Ledford, 2015). IDR comes in different sizes and shapes, what they have in common is active interaction across fields (Huutoniemi et al. 2010). When engaged in IDR there is interaction between disciplines which alters mono-centric disciplinary understanding (van Meerkerk & Slob, 2013).

Achieving IDR is hard due to crossing the boundary between natural- and social sciences (Kragt et al. 2016). Barriers to integration are present due to agreement that needs to be achieved on the scope, scale and what goals are pursued (Kragt et al. 2016). To cross boundaries between disciplines, and the different ways scholars view and define the problem, open mindedness and trust are required. Each distinct disciplines way of thinking and communicating is shaped by different views of the world embedded within a frame or multiple co-existing frames. In essence frames help to provide guidelines to select and pinpoint what information is salient and how it should be dispersed to different actors (Rein & Schön, 1993, Entman, 1993). Seeing beyond the scope of internalised frames requires an attitude involving openness to different perspectives (Kruglanski & Boyatzi, 2012). The concept of dialogue helps to understand what actors require from one another and jointly explore difficulties and openness to one another's frame (Isaacs, 1993, 1999, 2001). Dialogue can assist in attaining consensus and incorporating different views (Helling & Thomas, 2015). Especially regarding wicked problems that are too big to be faced in a unilateral way, they require cooperation to be dealt with effectively. Through dialogue a group can provoke a deeper understanding of collective awareness (Isaacs, 1993). The latter can help to acquire interaction across disciplinary fields and move beyond traditional divisions of knowledge. The essence of dialogue is change through speaking and listening to one another. Dialogue is about thinking in relationship with each other, opening up for other possibilities beyond individual assumptions or dispositions. It is a helpful tool in overcoming non-negotiable positions and disagreements over frames (Isaacs, 2001). Dialogue can be the catalyst for profound change and provide a basis for scientific knowledge integration. However, dialogue only opens up the possibility for unencumbered exchange. The theory of dialogue emphasizes the process, the outcome is usually less important.

To grasp the working relationship scholars face throughout Globaqua dialogue and trust are examined. Achieving a common understanding and (re)assessing one's own and other's held assumptions of the situation requires both trust and dialogue. The present study ties trust and dialogue with scientific knowledge integration. The model of Lewicki & Bunkers (1995, 1996) is incorporated to understand how trust can be fostered in dynamic relationships. What makes their model distinct from others is the absence of normative assumptions about what kind of relationship should be pursued (Paliskiewickz, 2011). The levels of trust they disperse serve different purposes. Both dialogue and trust are linked in a sequence: if one phase has been successful it might be possible to move on to the next. Although starting conditions such as time, language differences and lack of commitment influence the collaborative endeavour (Kragt et al, 2016, Siedlok et al. 2015, Trussell et al. 2017). For the present study it is vital to

understand what the degree of scientific knowledge integration is and the influence of dialogue and trust on scientific knowledge integration. Conducting research to knowledge integration across disciplinary boundaries is done via the Globaqua project by triangulating three sources of data. First, in order to measure knowledge integration published articles will be assessed through an analytical scheme developed by the author. Second, in order to measure how involved scholars think of the project questionnaires filled in throughout Globaqua will be examined. By doing so a timeline will appear, from the beginning towards the end of the project. Third, in order to measure a broader reflective approach qualitative interviews will be conducted. Acquiring more knowledge about what participants learned from the project when they reflect on the collaboration. The following main question is formulated: *What is the degree of scientific knowledge integration reached in Globaqua and what is the role of trust and dialogue in the process of coming to knowledge integration?*

2. Relevance

The evaluation of factors and conditions that add up to interdisciplinary research for Globaqua will be explored through both qualitative and quantitative assessment. Questionnaire data ranging from 2014 – 2018 will be explored. In addition to the questionnaires a qualitative case will be studied as well as module leaders that can elaborate on the cooperation. Respondents from the sampling campaign in the Sava will be interviewed to elaborate on the findings of the survey. The Sava river basin is an interesting case for two core reasons. First, the Sava river basin flows through several countries: Bosnia and Herzegovina, Republic of Croatia, Republic of Slovenia and Montenegro. Different cultures that were known for their volatile dispute over territory during the 90s are united in assessing the Sava river basin.
Second, the Sava river basin is one of the few basins that incorporated extensive fieldwork through sampling campaigns. Fieldwork implies that people actively worked and lived together for a short duration. After the fieldwork was conducted they worked on the results. Writing articles for the academia was done together. Due to this fieldwork it is possible to assess the development of IDR in a case study. The sampling campaigns were valued as being very successful and the incorporated informal interaction was seen as one of the core drivers. Module leaders can elaborate on the extent of cooperation within and between modules. More knowledge regarding the conditions that help to sustain dialogue and trust to achieve knowledge integration contribute to processes requiring IDR. In other words, how the latter practices can assist to profound collaboration in team endeavours such as Globaqua. These findings can help to assess what conditions are benevolent and what conditions are detrimental to scientific knowledge integration across disciplines. Especially the conditions that can constitute trust and dialogue to acquire scientific knowledge integration. Dialogue has often been used as a vehicle for large transformative change. It has a widespread use across various firms, such as technology firms, safety breakdowns in high hazard industries and collaboration between CEO's and their teams (Dialogos, 2018, Isaacs, 2001).
However, the concept has not been used in relationship with trust in working relationships before. Only in an implicit way; dialogue assists people in opening up for unfamiliar opinions and question their own assumptions. This does imply trust: trust that the other or the group open up to this reflexive process. The current approach is unique due to research in the relationship between dialogue and trust to constitute scientific knowledge integration.

The societal relevance of the present study rests on a deeper understanding of collaborative processes. Profound collaboration can contribute to solving aspects of water scarcity in an integrated way. Findings can contribute to acquire guideposts to adjust policies and increase water quality of bodies of surface water. Guideposts that are adopted on a large scale, rather than fragmented and different ways of measuring. Profound integration of water management, both practices and policies, can help Europe to synergise efforts to deal with environmental challenges. Conjoint efforts can assist in dealing with a plurality of stressors related to water scarcity.

3. Research question

The current section displays what sub questions will be employed in order to answer the main question. The main question is as follows: *What is the degree of scientific knowledge integration reached in Globaqua and what is the role of trust and dialogue in the process of coming to knowledge integration?*

Four sub questions have been formulated to answer parts of the main research question. First, assessing knowledge integration in Globaqua now most of the runtime of the project has passed. By employing a multimethod strategy a rich and encompassing image of Globaqua will be pursued.
Assessing the underlying assumptions, perceptions, dispositions and frames two concepts will be explored. In other words, the relational process is explored to acquire a sense of scientific knowledge integration in Globaqua. Second, this sub question is aimed at exploring trust as an incremental process: how trust developed throughout Globaqua by highlighting several encounters and findings.
Third, knowledge integration requires to assess one's held assumptions, dispersing them to others and implementing visions of other's which is done through assessing dialogue. Dialogue strives for thinking in relationship to one another and is a process that allows for creating novel things together. By assessing the degree of dialogue one can know which factors were beneficial for the collaboration and which were detrimental. Trust and dialogue can be seen in both formal and informal interactions.
Fourth, assessing major factors that are beneficial or detrimental to the development of knowledge integration and dialogue via the concepts of time, language and commitment. By doing so the impact of contextual conditions is examined. The degree of time, language and commitment shape starting conditions and influence the collaboration throughout Globaqua. These factors play a role in the development of dialogue and concern knowledge integration as well.

To address the general question fourth sub questions are formulated:

1. What is the level of scientific knowledge integration in Globaqua?
2. What is the level of trust in Globaqua?
3. To what extent has a constructive dialogue evolved?
4. How do time, language and commitment influence dialogue and knowledge integration?

4. Theoretical framework

4.1. Introducing the concept of Interdisciplinary Research (IDR)

Attractive in IDR is the interaction across fields, and therefore surpasses mono disciplinary boundaries to benefit from the contributing approaches. The overarching concept is knowledge integration. Combining findings and insights from various disciplines to benefit from information that would otherwise be fragmented across disciplinary boundaries. IDR requires interaction across disciplinary fields and communication with one another to work with unfamiliar ideas. The process behind integration could provide information on why insights were combined. Understanding IDR cannot be reduced to a single denomination but rather as a variety of different ways to bridge and confront the prevailing approaches (Huutoniemi et al. 2010). Disciplines are composed through historical processes. These processes produce and provide specific languages and methods which are used to conduct research (van Meerkerk & Slob, 2013).Therefore disciplines create their own views on how to conduct research, what method to use and what is relevant for a specific discipline. In other words, disciplines have a distinct way of framing that is unique, as are the benefits and drawbacks. The intent of engaging in IDR is to maintain the benefits of the contributing disciplines and overcoming the limitations of the prevailing approaches (Bammer, 2013). IDR typically involves research that combines insights from diverse disciplines working together on a complex real-world problem. When engaging in IDR there are multiple options to conduct research. Each of these options has distinct benefits and drawbacks (Bammer, 2013). IDR is usually preferred when dealing with complex problems, when joint knowledge production is pursued and when multiple stakeholders represent different interests (Van Meerkerk & Slob, 2013).
Knowledge integration requires profound interaction between research disciplines. Structuring knowledge was predominantly done through the lens of disciplinary specialization during the twentieth century (Klein, 2017). Disciplinary structure of science is inherited from nineteenth and twentieth century political organization (Wagner et al. 2011). Specialization in labor, professionalization in knowledge and restructuring of higher education resulted in rapid growth of disciplinary boundaries. For example the divide between social- and natural sciences in different domains, such as public administration and law as social sciences and life- and earth sciences under the domain of natural sciences. Subdomains with a wide array specific goals, methods and guideposts can be discerned.

The taxonomy of disciplinary specialization has become challenged. Fragmentation through specialization became a point of discussion. A shift in research occurred from an individual oriented approach towards a more team based- scientific collaboration (Klein, 1997). The main challenge is looking for possibilities to unite insights when dealing with real world problems. What induced this heightened interest in IDR is a shift of scope: from focus on basic research and scientific liberty back towards large scale societal problems (Ledford, 2015). Among the core drivers of this change are the need to solve societal problems, the complexity of nature and society and exploring problems that surpass the scope of single disciplines (Klein, 2017).

4.2. Integrative understanding – mono, multi, inter and transdisciplinary research

The discourse of IDR is involved with misconceptions regarding cross-disciplinary research: monodisciplinary, multidisciplinary, interdisciplinary, and transdisciplinary differ from one another and each possess distinct qualities. What needs to be addressed first is the definition of a discipline. A discipline stems from university organization and addresses research, teaching and how knowledge should be produced and reproduced (Turner, 2017). Disciplines are structured by defining a domain, their recurring objects of knowledge and protect their boundaries: composing standards and what practices should be adopted. Examples of setting these boundaries and to undergird their legitimacy disciplines publish journals, organize meetings and scholarly titles are protected from use by laymen (Turner, 2017). The pitfall of organising disciplines by setting boundaries is demarcation and fragmentation of knowledge. The ideal regarding unity of knowledge is threatened by disciplinary demarcation: significant topics may be discarded due to a mismatch between the domain of a discipline and the topic (Turner, 2017).

Mono-, multi-, inter-, and transdisciplinary research span a vast range of contexts (Klein, 2008). The first, monodisciplinary research does not cross disciplinary boundaries. Due to the conceptually similar and open characteristics of multidisciplinary, interdisciplinary and transdisciplinary research misconception is a well-known pitfall. Mono-, multi-, inter-, and transdisciplinary research vary in how they incorporate findings from other stakeholders. They range from no integration with different scientific disciplines to involving non-academic stakeholders such as policy makers and the general public.

Mono-disciplinary research consists of scientists that operate within the same discipline, thereby not crossing discipline boundaries. No perspectives or methods are shared and a single academic discipline is involved. Boundaries are maintained and exist between disciplines (Klein, 2013).

Multidisciplinary research is a conglomeration of disciplinary components, rather than a synthesis of mutual interaction which IDR strives for (Huutonimie et al. 2010). Multidisciplinary refers to the co-existence of multiple disciplines in a specific context. As opposed to IDR no knowledge integration occurs. The focus is upon coordination and cumulation of different approaches, therefore the contributing mono-disciplinary approaches do not mix. There is no integration of methods, approaches or measures. Multidisciplinary research is cumulative or additive rather than integrative (Huutonimie et al. 2010). Different approaches speak as separate actors, major parts of activities are conducted along the guideposts of disciplinary boundaries (Van Meerkerk & Slob, 2013). Huutonimie et al. (2010) show that multidisciplinary research is often done in collaboration, but disciplines are demarcated from each other through work packages. Work packages within multidisciplinary research cause disciplines to unite among their known peers, instead of forming a coherent structure with less familiar scholars (Huutonimie et al. 2010). Cognitive interaction between projects is often absent, research problems and methodological tools from scholars own disciplines are used.

On the contrary, interdisciplinary research is based on active integration across scientific disciplines (Huutonimie et al. 2010). Integration of knowledge through IDR can occur within a team of scientists or a single mind (Wagner et al. 2011). Cognitive interaction can also be done without a team or other collaborative structure. For our current purpose IDR conducted

through team effort is explicated. Interdisciplinary research consists of a integrative process that synthesizes knowledge represented by different disciplines to overcome boundaries set by prevailing fields of research (van Meerkerk & Slob, 2013). Research problems are framed together, as well as coordinated formulation and analysis of results. Interdisciplinary research strives to go beyond the sum of its parts: integration of data, methods, tools and theories is key to achieve integrative understanding (Huutonimie et al. 2010). Scholars strive for active synergy instead of compiling results of separated activities demarcated by disciplinary boundaries. In other words, researchers engage in a joint-production of a shared framework and collect and analyse data together (van Meerkerk & Slob, 2013). What scholars try to achieve is integrative understanding, providing a holistic picture of an empirical phenomenon (Van Meerkerk & Slob, 2013). Aligning disciplinary insights and collaboration between individuals who emphasize varying interests. Integrative understanding can be used to assess if and to what extent disciplinary approaches are combined. Indicators that show integrative understanding are consensus about composing a framework, developing a shared language which can be understood by different actors and a holistic picture of the research issue (Van Meerkerk & Slob, 2013). Unilateral ways to measure IDR, methodological indicators, are hard to single down. Combinations of qualitative and quantitative measures are present (Wagner et al. 2011, Huutonimie et al. 2013). Replicating these measures is often hard due to the unique combination of measurement that is tailored fit for a case.
Transdisciplinary research is hard to distinguish from IDR, overlap between the two is apparent: both strive for knowledge integration and creation of new approaches that exceed mono-disciplinary boundaries (Smitaite, 2016). Key difference is actors they incorporate, whereas interdisciplinary is between scholars, transdisciplinary includes both academic- and societal actors. Transdisciplinary research focusses on societally relevant problems and merges findings from different researchers with findings from actors outside the academia (Lang et al. 2012). Including actors outside the academia induces knowledge that is solution-oriented and useful for both parties. Joint learning processes between science and society in the corresponding discourses is expected (Lang et al. 2012). In contrast to IDR, transdisciplinary research is more solution-oriented both from the perspective of the academia as well as societally embedded actors. Integration and applying the produced knowledge is less prone to scholarly standards and an increase in solution-oriented thinking is likely.

Assessing to what extent knowledge integration has occurred is vital to demarcate processes from one another. As is shown, IDR has distinct qualities that can be separated from other types of integration. When engaging in IDR one strives for active synergy across disciplinary boundaries. One of the core drivers is synthesizing knowledge and practices between scholars, surpassing solemnly cumulating results together. Integrative understanding is what one strives for. Table 1 shows the types of integration between disciplines, adapted by the author from Bark et al. (2016). The level of integration can be measured along the line in (A) and (B) shows the types of corresponding integration.

Level of integration (A)	**Types of integration (B)**
Highly integrated 	‘Transdisciplinary approach is a reflexive, integrative, method driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge (Lang et al. 2012, p. 26)’.
	Interdisciplinary approach is hard to define in an all-encompassing definition, as it is often used as an generic concept (Huutoniemi et al. 2010). Various academic perspectives are combined. Interaction between different disciplines through synthesis of knowledge and practices between scholars (Smitaite, 2016).
	Multidisciplinary approach refers to the co-existence of multiple disciplines in a specific context without integrating or altering their disciplinary methods in a significant way (Huutoniemi et al. 2010, Bark et al. 2016).
Not integrated	Mono-disciplinary projects, scientists from the same discipline collaborate with one another, no sharing of methods or perspectives is pursued (Bark et al. 2016).

Table 1. Level of integration versus type of integration. Adapted by the author from Bark et al. (2016).

4.3. Framing – selection and salience of perceived reality

Disciplines each have distinct approaches and methods they deem valuable and are comfortable with. How they see, perceive and process information is embedded within a frame. Framing is a way of selecting, organizing and making sense of reality to provide frameworks on how to act (Rein & Schön, 1993). A major challenge for IDR is aligning frames as scholars tend to frame their world in a variety of ways. Framing is a way to perceive reality and as Entman (1993) describes it is focussed on selection and salience:

To frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described (p 52).

Frames help agents with defining problems, these are usually embedded in common cultural values and a nested context (Rein & Schon, 1993). Frames also help to identify causes through diagnosis. Different frames perceive agents and suggested treatments of the defined problem in a different way (Entman, 1993). What frames essentially do is making pieces of information more noticeable or meaningful to various actors (Entman, 1993). In other words, frames help to provide guidelines for participants to perceive social realities and present themselves to others (van Hulst & Yanow, 2016).Problematic about framing is that it leads to different views of the world, and therefore creates a multitude of social realities. Scholars working in different disciplines have different frames and tend to interpret, act and approach what needs to be done in a different manner (Rein & Schön, 1993). However, not all frames and constitution of social reality are equally acceptable or compelling (Rein & Schön, 1993). Criteria inherited from disciplines provide guidelines on what is likely and what isn't considered to be a fruitful frame. It is hard to assess frames as they are part of a taken-for-granted view to select and choose what information is salient. Frames form the role actors play in judging thoughts and actions (Rein & Schön, 1993). Distinguishing between disagreements and controversy across frames is linked to commitment. When committing to a certain frame, usually a dominant one, actors hope to gain enough momentum to act. Other options could be neglected and have to make way for the dominant frame (Rein & Schön. 1993). Disagreement over what comprises the ''facts'' of the situation between contending parties could occur (van Hulst & Yanow, 2016).
In other words, each discipline has a different frame, or even contesting frames within a discipline. Aligning these frames is challenging, as information is perceived and weighed differently by actors. Synthesizing knowledge through IDR can prove challenging due to disagreement caused by different frames.

4.4. Starting conditions – atmosphere and open-mindedness

Atmosphere and open-mindedness serve as the starting conditions for a fruitful dialogue. These concepts form the guideposts for a fruitful dialogue due to the exchange of wants, preferences and held assumptions and are building blocks for a fruitful dialgoue. Since trusting one another depends on knowing what one wants, and is based on previous interactions atmosphere and open-mindedness contribute to the degree of trust as well.

What is required to consider other frames, and integrate knowledge among actors, is open mindedness. Open mindedness refers to being open to assess and acquire unfamiliar information (Kruglanski & Boyatzi, 2012). Open mindedness can help to attain dialogue through questioning held assumptions and beliefs. When being open minded it also means being open to contradictory perspectives (Kruglanski & Boyatzi, 2012). In other words, being open to perspectives dispersed by others despite the outcome the newly acquired information could have. Open mindedness can assist in decision-making: all the options are weighed and information that contradicts leading frames is also taken into account. An essential facilitating condition for dialogue is an atmosphere that promotes cooperation between participants. Relationship building and social exchange enhance the group atmosphere, and therefore open up the possibility to think in relationship. When interpersonal contact is promoted, knowledge sharing is enhanced (Chen & Huang, 2007). The atmosphere felt during the collaboration is vital for openness and sharing of knowledge (van Meerkerk & Slob, 2013). An informal atmosphere helps to constitute informal discussion and assess what other disciplines can contribute to group projects (van Meerkerk & Slob, 2013). Organisations that oversee the collaboration can help employees to think freely, and to communicate about their opinions and findings, and also explore uncommon alternatives (Chen & Huang, 2007). They can do so by organising activities such as informal trips and group sessions that enhance profound collaboration over a period of time (van Meerkerk & Slob, 2013).

4.5. Dialogue – supporting disciplinary integration among actors

For the current purpose the concept of dialogue is used to assess the aggregate of private, informal and unencumbered exchange. Especially focussed on scientific knowledge integration across disciplines. Dialogue can be used as a tool to overcome non-negotiable positions, disagreements over frames, which can be held as necessary positions (Isaacs, 2001). A dialogue assists in achieving mutual understanding through re-examination of own and other's frames (Roberts, 2015). Overcoming habitual roles and polarization that taint the communicative endeavour. To address concerns of larger communities, that is scientific disciplines, a dialogue can prove fruitful (Helling & Thomas, 2015). A dialogue is a vehicle to achieve movement towards consensus on goals or issues and can assist to incorporate diverse views before making a decision (Helling & Thomas, 2015). Complex and wicked problems are too big to be faced by single actors. Dialogue harnesses collective intelligence, cooperative endeavours exceed the possibilities of the individual (Isaacs, 1999). The core of dialogue rests on the premise of shared attention that is able to provoke a deeper understanding of collective awareness (Isaacs, 1993). Dialogue serves as a disposition, based on profound listening and speaking to each other as a vehicle to achieve integrative understanding. In other words, getting to know the perspectives of other's methods, scope, approaches and why scholars use these approaches. Dialogue is about opening up for unfamiliar views and approaches. Originating from the Greek words dia and logos, dialogue as a concept has a widespread use (Isaacs, 2001). Dia means through and logos translates to word or meaning, combined dialogue means a flow of meaning. Another connotation of logos is to gather together, in relationship (Isaacs, 1999). Dialogue can assist in letting go of taken-for-granted frames and acknowledge in relationship what information is salient. In other words, dialogue is a conversation in which people think together in relationship with each other. Individual positions are no longer considered as final and possibilities presented by others are taken into account (Isaacs, 1999). Surpassing viewpoints and engaging in a process of shared meaning is key (Isaacs, 2001). Dialogue is a process of engagement and listening to one another fully, beyond constraining influences to enhance mutual understanding (Roberts, 2015).

The essence of dialogue is to drop barriers between people, transcend boundaries and in engage in unreserved exchange (Isaacs, 2001). However, in practice breakdowns in communication are frequent: refusing to participate, polarization and emotions such as anger and being upset taint the communicative process. Dialogue isn't necessarily about agreement, it is about jointly exploring difficulties and openness to one another's frame. Instead of uniting and developing novel ideas together, polarization and discussion often prevail in community endeavours (Isaacs, 1999). Defending one's own positions and assumptions is a common obstacle when working together. Dialogue and discussion are different from one another. Discussion is about making a decision, choosing between alternatives. Difficulties are resolved by choosing any of the, usually dominant, frames and dismissing the alternatives. Dialogue is about exploring the presented choices: what held assumptions lie underneath and the possibility of engaging in free flow of meaning (Isaacs, 1999). An atmosphere or field to express oneself and hear others is of vital essence to fulfil the potential of dialogue. Listening to one another can only occur in a field that inhabits a so called container. A container is a setting in which conversation can occur. Not all containers are resistant to the same sorts of

pressure, they can evolve and deepen over time. Development over time causes the container to endure more pressure what opens up the possibility for a higher phase in the container (Isaacs, 1999). More developed containers allow the possibility for creating together. If the container matures it is able to endure more pressure, opening up the possibility to challenge other's views and integrating various unfamiliar influences (Roberts, 2015). If the container does not allow the pressure presented by the involved actors, people will avoid issues and remain at the level of discussion (Isaacs, 1999). Tacit knowledge, embodied knowledge, remains unquestioned and unfamiliar options remain unexplored. Suspending assumptions is the vital aspect to explore underlying assumptions. (Isaacs, 2001). Moving beyond assumptions to attain a dialogical stance: becoming conscious of the development of meaning as it arises (Isaacs, 2001). Dialogue is a process that allows to explore a variety of approaches and styles in an unencumbered way. Within the container a field of conversation emerges. Every field has distinct characteristics, patterns and crises (Isaacs, 1999).

Isaacs (1999, 2001) provides four phases that range from concern for safety to generating collective perception. The four phases start at instability of the container, instability in the container, inquiry in the container and the highest achievable phase is creativity in the container.

Instability of the container, members are concerned with safety and trust in the dialogue (Isaacs, 2001). A container holds the collective aggregate of assumptions, shared intentions and beliefs (Isaacs, 1993). A group atmosphere or climate is maintained on basis of this collective aggregate (Isaacs, 1993). Members do not know one another well and/or people meet each other for the first time. Instability of the container occurs, not much pressure or intensity can be held (Isaacs, 1999). Interaction is fixed through inherited norms and embodied assumptions. In other words, group members have a fixed image of what should occur. Based on this image they discern rules about how to think and act within the given situation (Isaacs, 1999). What people really think and feel does not surface: the fixed image and inherited norms are dispersed to each other.

The first phase, instability of the container, comes down to speaking with each other based on the premises of deliberation (Isaacs, 1993). People weigh out dispersed frames: if they agree and if they like the shared assumptions or not. Socially generated norms and embodied assumptions are presented and group members operate within this given scheme and rules (Isaacs, 1999). Mapping differences and questioning the prevailing norms and rules isn't done, no reflection on the process is conducted. Instability of the container is also known as politeness, people behave within the given scheme and do not express what they really think. Politeness stems from establishing a level of safety in an unfamiliar environment (Isaacs, 2001).To move beyond instability of the container a series of crises occur. A crisis is necessary to come to a deeper understanding and provides guideposts to distinguish the prevailing acts and everything that comes after (Isaacs, 1999). When engaging in dialogue people realise they cannot come to the level of shared meaning as fast as they intended to. A crisis of emptiness occurs, ridding oneself of expectations to open the possibility to novel things. In essence the crisis of emptiness is about realising that knowledge arises because of a shared experience (Isaacs, 1999). The assumption that only a single individual has the required knowledge is abandoned. Responsibility for the shared process and community activity is provoked. People abandon the position of politeness and weigh assumptions, which leads to instability in the container.

Instability in the container, people start to say what they think resulting in breakdown within the container (Isaacs, 1999). Struggles with fragmentation occur, conflicts over whose assumptions are the most valuable and powerful are expressed (Isaacs, 2001). Collision and smashing into another verbally is resembling the second phase. Problematic is that not many groups get past these move-oppose sequences and remain on the level of breakdown (Isaacs, 1999). Similar to instability of the container, people do not reflect on what is happening, dispersing held assumptions to one another is done. Inquiry in why these assumptions and thoughts are held is not present (Isaacs, 1999).

The danger presented in phase one and two is that of an endless cycle between politeness and breakdowns. After frustration and anxiety the position of politeness is retained and the community activity comes to an halt, no unencumbered exchange of meaning is attained (Isaacs, 1999). To overcome this endless cycle the crisis of suspension is required. Core argument of this crisis is seeing oneself apart from the dispersed views, the held point of view is not what I am (Isaacs, 1999). Seeing these two apart from one another opens up the possibility of willingness to listen to other views. Suspending one's views creates inquiry in the group activity and the (endless) cycle between phase one and two is discontinued.

Inquiry in the container, participants inquire into polarization and unfamiliar ideas (Isaacs, 2001). Struggles over power and whose assumptions and opinion is deemed the most valuable are abandoned. A shift occurs from third person perspectives to that of first person perspectives. Inquiry into personal views is shared with the group: how things look from individual views, rather than speaking on behalf of the group or other people (Isaacs, 1999). People become more willing to express they cannot provide all the answers and acknowledge that assumptions are not always held in such a strict manner. People begin to notice and explore their own assumptions (Isaacs, 1999).

What is different from phase one and two is that the need to align with others through politeness and reaching agreement is absent (Isaacs, 1999). The distinct feature in this third phase is the ability to speak across assumptions and different frames. Sensitivity to embodied assumptions that were formerly accepted as true (Isaacs, 1993). Connecting with people that are very different from themselves is a distinguishing feature of the third phase. The opposite can also recur: people realise just how little understanding there is between them (Isaacs, 1999). The depth of the disconnection between the group members is felt, resulting in the crisis of fragmentation (Isaacs, 2001).The crisis of fragmentation is about loosening the preconditions within a group about who they think they are and what should be achieved in the communicate endeavour (Isaacs, 1999). Group members loosen up these preconditions in such a way that a much wider pallet of possibilities becomes available. It is about letting go of an isolated identity and getting a deeper understanding of the collective potential (Isaacs, 1999). In other words, a collective identity or understanding is provoked through the crisis of fragmentation. If the potential for the collective is embraced creativity in the container can occur.

Creativity in the container, the rarest of all phases. People have an increased understanding of the whole and are able to consider genuinely new possibilities (Isaacs, 1999). Each other's views and assumptions were explored in the previous phases. Distinct from the third phase is a sense of collective flow. Breakdowns and defending positions is also put in perspective, awareness of what people say in the group affect the whole. The container has matured and is

able to endure far more pressure than the first three phases. Opposition and polarization are abandoned and make way for a sense of common meaning (Isaacs, 1999). Alignment and connection are felt within the group. Synchronization between actors that differ in viewpoints is obtained. People do so by discussing their own frames, comprised of memories how things have been and how they experienced this. Questioning and thereby ceasing these past memories creates the possibility to reflect on the subjects that have surfaced during these phases (Isaacs, 1999). People become conscious of what it meant for them to participate in the process of dialogue. A humble position is attained: collective awareness is valued much more than individual frames and assumptions. Engaged in a shared process that allows for re-examination of own frames and other's frames and see how this fits in the collective endeavor (Isaacs, 1999). Another feature of creativity in the container is that paths to resolution can occur. The insights stemming from questioning assumptions, both from oneself and the other, can create possibilities for shared action on issues that have long been disputed.

Dialogue can help to reassess one's own and other's frames and contest why and what information is fruitful. Vital in the process is ensuring that collaboration benefits from multiple perspectives held by various disciplines. The process of dialogue can help to overcome held assumptions and synthesize knowledge and practices between scholars. Crossing boundaries between disciplinary watersheds and active integration across scientific disciplines. A process that can be the catalysator when integrating data, tools, and theories. Achieving a comprehensive result, that goes beyond the sum of its part, and hereby supporting interdisciplinary research.

4.6. Trust in interdisciplinary team collaboration

Collaboration in interdisciplinary teams requires trust in one another, developing a joint-framework and assessing data together means trust needs to be established. Disciplinary findings also have to be communicated to others which are unfamiliar with the dispersed information. A major part of IDR is aligning individuals who emphasize varying frames regarding research. Profound collaboration among scholars is required to pursue novel, integrated ideas. Trust in one another is required to constitute the process of IDR, as scholars need to pursue a shared goal. Interdisciplinary team collaboration relies on connectedness or dependence on sharing of resources and commitments (Klijn, Edelenbos & Steijn, 2010). Each party depends on the other and is often unable to control or alter the behaviour of the other (Paliskiewicz, 2011). Risk, vulnerability and expectations accompany engaging in trust relations. Willingness and opening up to a vulnerable position is required (Klijn, Edelenbos & Steijn, 2010). Trust refers to a trustors estimation of the probability that preferred or expected behaviour occurs (Moyson, van de Walle & Groeneveld, 2016). Assuming that another person will keep promises in a specific situation requires vulnerable exposure (Moyson et al. 2016). Trust in one another is based on past interactions, if a trustee behaved in a trustworthy manner the expectations of the other are met. In other words, trust requires trust-building that can be enhanced over time. Trust is an interactive process that involves two or more individuals that learn about each other's trustworthiness (Paliskiewicz, 2011). Dynamics that are measured are based on positive feedback, the initially showed behaviour is reinforced (Zand, 1972, as shown in Paliskiewicz, 2011). Trust is not a linear process, it builds up incrementally through previous behaviour. The opposite can also occur, a decline of trust when promises are not met. Absolute certainty that the trust in the other will be honoured cannot be assured.

To assess trust a wide variety of sources can contribute. Lewicki & Bunkers (1996) provide a dynamic model of trust. Their approach is distinct from others, no normative assumptions about what relationship is best are pursued (Paliskiewicz, 2011). Three different types of trust that emerge and evolve over time regarding trust in working relations are linked with each other (Lewicki & Bunkers, 1995; 1996). When understanding how trust can be fostered insight in how relationships change, grow and decline is gathered (Lewicki & Bunkers, 1995). The model of trust is linked in a sequence: if trust has been established at one level, the possibility to move to the next level is achieved (Paliskiewicz, 2011). In other words, these levels of trust can be seen as cumulative stages that build on the experiences gained in the previous form of trust. The levels of trust discerned are calculus-based, knowledge based and identification based trust. As trust increases and parties get to know one another better they could cooperate on a more profound level. Important in this threefold distinction is the time-factor and keeping promises to meet expectations between trustor and trustee. More information about the other creates the foundation for a transition to the next stage (Lewicki & Bunkers, 1996). If parties do not see the added benefit of engaging in a more profound relationship the development will come to an halt. Each stage of trust provokes a follow- up through gathering information of the corresponding stage (Paliskiewicz, 2011). Calculus-based trust requires gathering information to decide what opportunity seems valuable. The foundation for the next stage is formed. In other words, achievement on one level of trust enables the development of trust at the following level (Lewicki & Bunkers, 1995). Note that not all relationships will reach the final type of trust. Various constellations of trust are

possible, most people want and have different relationships that serve different purposes (McAllister, Lewicki & Chaturvedi, 2006). Many work-relationships tend to be knowledge-based relationships: lack of time or energy to invest hampers or stalls the development of trust (Lewicki & Burgers, 1996).

The most basic and first trust relationship is that of calculus based trust. The costs versus the benefits are weighed against one another: is it viable to build up a relation? Calculus based trust is a very rational approach to trust and involves deterrence: the costs of betraying the engaged relationship (Lewicki & Bunkers, 1996). Calculus based trust is the first step to an enduring and longstanding relationship among trustor and trustee. This view incorporates a market-oriented calculation to determine value and weighing the costs versus the perceived benefits (Lewicki & Bunkers, 1996). Only some relationships are weighed as valuable, The predicted benefits outweigh the risks of engaging with the other. Engaging in a relationship is seen as a form of transaction whereby the benefits and costs are weighed. At the core of calculus based trust lies the possibility to impose sanctions for deterrence. Calculus based trust relies on the value of benefits and the costs of cheating, and therefore the possibility of imposing sanctions on violating trust is important (McAllister et al. 2006). Deterrence is based on the fear for the sanction, which should reinforce the promises to the other party (Lewicki & Bunker, 1995). If sanctions are not available the risks increase and more profound cooperation is often weighed as a risky endeavour.

When the trade-off is seen as beneficial the second type of trust, knowledge based trust, can be attained (Lewicki & Bunkers, 1996). A fundamental paradigm shift has occurred to reach knowledge based trust: from emphasis on contrasting differences to assimilation between the self and the other. Grounded in predictability of the other, anticipating on the behaviour the other or others show (Lewicki & Bunkers, 1996). Providing an answer on the following question is guiding for knowledge based trust: what will he or she do? Experience of working together and regular communication help constitute knowledge based trust (McAllister et al. 2006). The main constituting element for knowledge based trust is information of the other, knowing one another better enhances predictability of behaviour. Information for knowledge based trust is acquired through regular communication and courtship (Lewicki & Bunkers, 1996). Regular communication is a key process due to the exchange of wants, preferences and approaches to problems. Without regular communication the ability to predict reactions of the other and to think alike is lost (Lewicki & Bunkers, 1996). Courtship is directed at relational development and learning more about others. A more educated image of the other helps to assess whether to commit or not. Information gathering is done through interviewing the other and learning how others behave in different situations (Lewicki & Bunkers, 1996). In other words, it is about cultivating relationship and experimenting in different situations to provide a general view of the other.

The third and most profound type of trust is identification based trust: getting to know desires and intentions of the other parties (Lewicki & Bunkers, 1996). A shift to knowing one another to identification with the other occurs, evolution on a more personal level (Lewicki & Bunkers, 1996). Appreciation and understanding of what the involved parties want is present. This type of trust requires the most time to develop due to knowing the other's wants and what actions have to be undertaken to maintain the other's trust (Lewicki & Bunkers, 1996). Identification-based trust relies on confidence that the other represents interests and that no surveillance or monitoring of the actor is required. The possibility to serve as substitute for

the other party is created, each party is prepared to support one another to pursuit their goals (McAllister et al. 2006). Knowledge-based and calculus-based trust are stages of trust that help constitute the level of knowing the other that is required for identification-based trust. In other words, identification-based trust requires to think and act like the other (Lewicki & Bunkers, 1996). Behavioural traits are incorporated in the relationship between the trustor and the trustee, harmonization is what occurs (Lewicki & Bunkers, 1996). Activities that strengthen identification-based trust are develop a collective identity, sharing the same building or neighbourhood, joint product creation or mutually shared objectives and committing to commonly shared values (Lewicki & Bunkers, 1996). Athletes, interactive work groups or prize winning soccer teams are examples of identification-based trust (Lewicki & Bunkers, 1996).

In regard to IDR, it is likely that the level of trust will have various characteristics from knowledge-based trust and identification-based trust. Since the scholars in Globaqua are united through their mutual commitment to the project it is unlikely they base their trust on a form of deterrence. Scholars communicate with one another on a regular basis to provide feedback on their current work. The wants and understanding of what involved parties want is present (Lewicki & Bunkers, 1996). However, the Globaqua project is heavily monitored through multiple layers of management, i.e. module leaders. It is likely that actors are monitored, often on the output they should achieve. Globaqua is structured in different work packages that each serve a different function as described (DOW, 2013). The scholars in the Sava case RB did share a building and have the conjoint responsibility to create products. In this sense they are comparable to work groups that Lewicki & Bunkers (1996) provide as distinct examples of identification-based-trust. A lack of time and effort might reduce the development into the identification-based level of trust. It is likely that they combine their fieldwork with various other research activities, not related to Globaqua. A constant process of negotiation and re-negotiation of interests is expected: framing results and coordinating formulation of results requires active synergy (van Meerkerk & Slob, 2013). Since scholars have to deal with novel and unfamiliar approaches regarding research they will most likely want to engage in a constant process of communication. Being able to represent one another and serve as a substitute might be difficult. This would require profound knowledge of the disciplinary insights from the representee. Indicators of a shared framework that contribute to integrative understanding are to be expected (Van Meerkerk & Slob, 2013).Only a few relationships can be characterized as identification based trust. Due to the influence of time and effort that are required to get to know the other on a profound level not much relations will reach this type of trust. Not every working relationship requires such profound knowing of the other. Relationships serve different needs.

Assessing trust in Globaqua is to acquire more knowledge of aligning interests. Since interdisciplinary teams rely on the same resources and commit to project goals they need to establish at least a working relationship to pursue project demands. Globaqua is reaching the deadline and it is fruitful to assess how trust developed and what contributed to the relationship among different scholars. Incremental enhancement of trust can be expected, although detrimental factors need to be acknowledged as well.

4.7. Factors influencing collaboration – Time, language and commitment

Work within contemporary organizations is done by interdisciplinary teams in an increasing rate (Siedlok et al. 2015). Challenges caused by time, language and commitment should be addressed.
These factors have in common that they can hamper the development, and thereby reducing or interrupting collaboration. Both internal and external obstacles should be taken into account. Differences might seem incommensurable at first (Trussell et al. 2017). Communication is a key process in interdisciplinary work. It can all be singled down to one core subject, understanding the other. Problematic is that each disciplines way of thinking and communicating is framed in a very different way (Kragt et al. 2016). Without listening to one another it is impossible to use dialogue as a vehicle to advance communication (Isaacs, 1999).

One of the most common challenges for interdisciplinary collaborations is the time factor. Due to the varying backgrounds interdisciplinary teams require additional time to acquire joint understanding of research questions, concepts and communicate about expectations between actors (Kragt et al. 2016). Models and research activities require coordination among the involved actors. Acquiring input from all project partners at the start of project can be time-consuming. Especially understanding how other, unfamiliar, disciplines can contribute (Bruce et al. 2004). Coping with the challenge of time can be approached in various ways. Kragt et al. (2016) cope with the demand of time by organising meetings prior to the funding of the project to develop a shared vision about goals, objectives and to align expectations. Bruce et al. (2004) emphasize a different approach: developing an agreed glossary of terms and their meanings to improve integration and meanwhile including space for 'social time'. The latter means there is room left for activities not directly related to project demands, helping to foster ties between involved actors and thereby contributing to the project in a positive sense. Campbell (2005) notes that researchers should incorporate and ensure that enough input from the involved actors is acquired from the start of the project. According to Campbell (2005) it comes down to establishing protocols to clarify what is required. What Kragt et al. (2016), Bruce et al. (2004) and Campbell (2005) have in common is incorporating time to discuss and communicate about activities and composing research goals together. It should be emphasized that not only the starting phase of interdisciplinary research requires additional time. Specific management modules are required to foster interdisciplinary collaboration. A specific module, or project partner, should foster the interdisciplinarity and specific activities to stimulate interaction and understanding among the involved actors (van Meerkerk & Slob, 2013). The latter also requires additional time.

Language barriers between disciplines exist: specific jargon predominantly used within a discipline is hard to transfer to a very different discipline. Jargon, or discipline specific language is usually embedded within a context and provides a frame on how to acquire valid and reliable knowledge (van Meerkerk & Slob, 2013). Language barriers are often the most difficult to overcome between natural- and social sciences: their epistemological basis is highly differential. The barrier is problematic when the vocabulary is not the same among disciplines and a gap between participant's technical background persists (Bruce et al. 2004). The possibility of agreement over a common language or field should be assessed. What needs to develop is a shared understanding and research synergy. Shared understanding can emerge during the collaborative process, it is rather an intermediate outcome than a

prerequisite for collaboration. If shared understanding exists a lack of problem awareness and disagreement over what comprises the problem occur (Lang et al. 2012). A common language needs to be developed, as disciplines need to select and combine different disciplinary insights. Dispersing and communicating findings with a mixed group of scholars should be done based on a common understanding of the issue at stake and discipline specific jargon should be abandoned (Kragt et al. 2016). Ill-defined goals hamper the interdisciplinary collaboration and cause divergence of interests. Weaving together insights to acquire a coherent image is what scholars involved in IDR strive for. In other words, they need to develop a shared language to form an overarching framework that brings together participating disciplines.

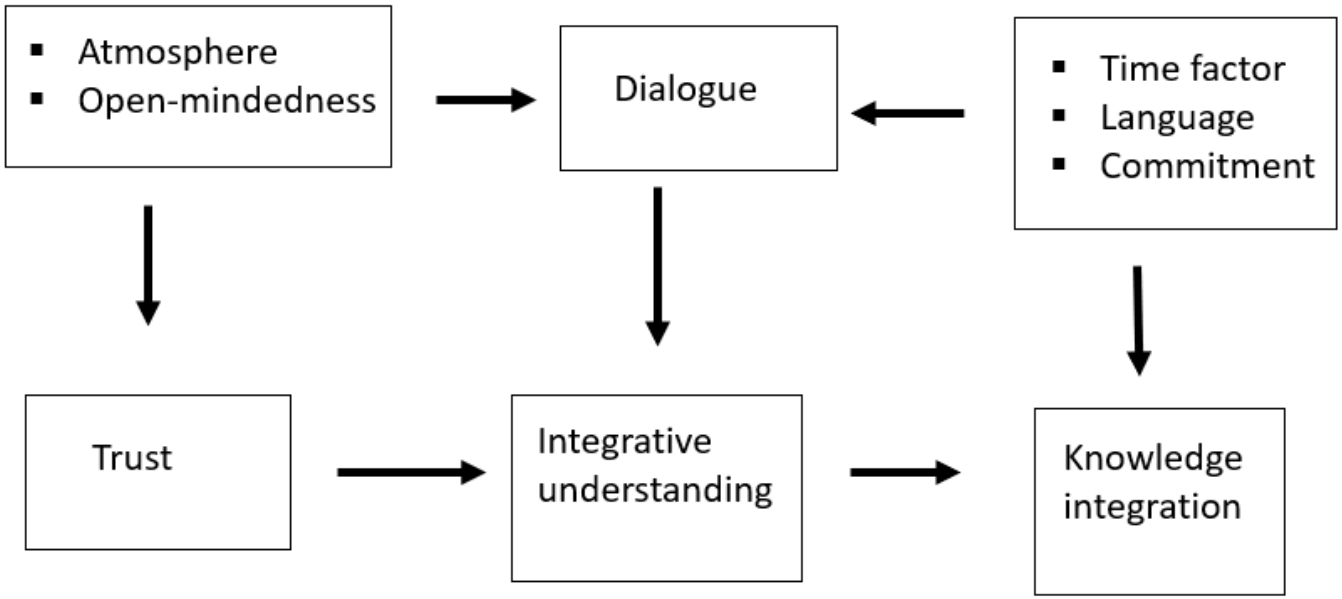
With regard to commitment, team members need to be actively engaged in the process (Trussell et al. 2017). Eager and active motivational drivers should be pursued to engage in a collaborative process. An essential factor is the willingness of team members to engage in the process, wanting to actively contribute to interdisciplinary research and invest in getting to know unfamiliar research practices (Trussell et al. 2017). Commitment to explore disciplinary bias and to create novel research synergies (Trussell et al. 2017). Commitment to the process is especially important due to the impediment on efficiency that can occur in interdisciplinary research: the quest for publications can be slowed down due to the novel skills that and unfamiliar literature that has to be explored in order to benefit the interdisciplinary research endeavour. Eagerness and willingness is tested due to the uncertain nature of IDR and the hampering effect it could have on one's individual career. Usually more time is needed to acquire novel skills and the amount of publications in a familiar discipline are usually higher compared to pursuing an interdisciplinary approach. In other words, due to the capricious nature of IDR profound commitment is required from involved scholars to actively pursue and contribute to IDR.

The collaboration in IDR is affected by time, and especially how much time is spend in the development phase of a certain project. Input needs to be acquired from various actors and various ways to deal with communicating among actors are presented. Investigating and getting to know the other's wants and preferences prior and during the project are essential. This means additional time is needed to establish a fruitful collaboration. Defining problems, integrating objectives, contacting the right people and assessing unfamiliar methods all require time (Campbell, 2005). These problems require breakdown of constructs and assumptions in an ongoing highly reflexive process (Trussell et al. 2017). Writing outside one's traditional area of expertise requires additional time over the discipline one is accustomed to.

Language barriers, or discipline-specific jargon can exist as well. Agreement over a common framework and setting goals together can help to tackle this issue. Frequent communication about findings to eventually reach a common language, or to a lesser extent understanding of what one another means by specific concepts. Interaction among each other is a vital component in acquiring research synergy and getting to know the concepts that are used throughout a conjoint research.

Commitment to processes of IDR requires the willingness to achieve interdisciplinary research. Committing to IDR requires researchers to embrace an approach that is capricious by nature: usually less publications are composed and they require additional time and motivation from the involved researchers.

5. Conceptual model



5.1. Role of the conceptual model in the research

The model depicted above requires more elaboration, the relationships between the concepts will be explained throughout this paragraph. The vantage point in this study is to assess the degree of scientific knowledge integration and the influence of trust and dialogue on Globaqua.

A degree of dialogue and trust within processes of collaboration are required: they are both guiding in the way a research is conducted. They can serve as constituents for IDR. To acquire a profound collaboration, where knowledge is synthesized between actors with fundamentally different predispositions, trust and dialogue are necessary conditions. Through the dialogue scholars get to know predispositions, assumptions and beliefs. Forming an image of the other and what he or she deems valuable regarding research is easier to assess. Dialogue and trust serve as the building blocks, the underlying principles for extensive collaboration. Both concepts require getting to know one another to explore joint possibilities for cooperation. Undergirding getting to know the other are two major social processes: open mindedness and atmosphere.
First, open mindedness is needed to develop oneself and the group dynamics (Kruglanski & Boyatzi, 2012). Open mindedness helps to test assumptions and held beliefs and being open to contradicting perspectives. The second undergirding social process for dialogue and trust in the collaborative endeavour is the atmosphere within the group process. Promoting relationships and interpersonal contact can enhance getting to know dispositions, wants and preferences, and therefore increase the degree of dialogue and trust. Atmosphere can help to discuss held assumptions, beliefs and to determine goals together (van Meerkerk & Slob, 2013, Chen & Huang, 2007). Dialogue and trust help to constitute integrative understanding: if both dialogue and trust are low it is unlikely that mode of integration is high. This effect probably works the other way around as well. If both dialogue and trust have developed it is likely that a higher mode of integration can be attained. This research aims at elaborating on the connection between the three concepts: inquiring know-how in IDR collaborations and hereby learning what conditions are beneficiary for collaboration among scholars. Especially focussed onto knowledge integration among scholars that fundamentally differ qua epistemological predispositions. Trust and dialogue can assist in bridging the gap and elucidate learning from each other in a collaborative endeavour. Both can serve as key constituents for an integrated way of explaining and understanding of empirical phenomenon through integrative understanding. Knowledge integration relies on the degree of integrative understanding that is achieved: Compiling a synergy of research results, including a shared framework and collecting and analysing data together. Getting a deeper understanding of the major determinants is done through assessing the collaboration in multiple ways, see chapter 6 regarding the method.

However, it is important to take note major factors that directly influence the degree of knowledge integration and the degree of dialogue via the concepts of time, language and commitment. The three factors are chosen based on their effect on conjoint interdisciplinary research: time, language and commitment are commonly cited in IDR and public administration literature (Kragt et al. 2016; Siedlok et al. 2015; Trussell et al. 2017). These factors directly influence the degree of knowledge integration and the degree of dialogue: when a surplus of the three is found more profound knowledge integration and a higher

degree of dialogue can be expected. All three concepts contribute to the degree of dialogue and essentially come down to the effort that is that is put in trying to achieve a profound collaboration with one another in terms of time, understanding each other via language and willingness to make the collaboration work. Essentially they are elements that are either detrimental of contributing to thinking in relationship with one another, and are therefore building blocks for dialogue. Time, language and commitment are aimed at knowledge integration and dialogue due to their relation to project planning and the effect they have on collaborative endeavours. Common measures for time, language and commitment setting milestones, making a glossary of common concepts and how the project design allows for interaction. The level of knowledge integration and the degree of dialogue that has been reached influence the overall degree of collaboration achieved in Globaqua. Time, language and commitment serve as a starting condition for any collaboration and can constitute a fruitful working environment to work with one another.

6. Method

The present research will use a multimethod approach, by combining qualitative and quantitative approaches a deeper understanding of the research problem can be explored (Azorín & Cameron, 2010). A multimethod approach is explored to grasp a broader perspective than monomethod studies (Azorín & Cameron, 2010). In other words, multiple sources of data collection techniques will be used to study a single problem (Patton, 2002). For the present study three sources of data will provide an overarching image of the knowledge integration within Globaqua. To be specific, multiple methods will be applicated; a combination of qualitative and quantitative approaches to compose the research methodology of the present study. Vital is overcoming errors presented by single method studies, especially biased responses. These responses may include self-reported variables such as job satisfaction and work behaviours (Conway & Lance, 2010). Overcoming the common method bias (CMB) is strived for when adhering to a multimethod study. CMB means that the sample is inflated by the method (Conway & Lance, 2010). MacKenzie & Podsakoff (2012) state that a series of factors could undermined the capability of the respondent to answer the question properly. One of the core arguments for CMB is striving for an easier way out: investing less effort by filling in what seems appropriate within the given answer possibilities (MacKenzie & Podsakoff, 2012). In other words, the used method causes a bias due to the fact that all variables are scored by the respondents themselves. The pitfall is known as satisficing, providing answers respondents deem appropriate within the presented format (MacKenzie & Podsakoff, 2012).
For the current purpose using different types of data will provide a cross-data validity check (Patton, 2002). Quantitative survey data will be complemented with two qualitative methods: article analysis via an analytical tool and primary and secondary interviews. To acquire an image of how the concepts are measured the below mentioned table can be consulted.

Variable	**Method for measuring**
Atmosphere and open-mindedness	Quantitative survey, Sava RB interviews and interviews with module leaders
Trust	Sava RB interviews and interviews with module leaders
Dialogue	Quantitative survey via open ended questions, Sava RB interviews and interviews with module leaders
Time, language and commitment	Quantitative survey via open ended questions, and interviews with module leaders
Integrative understanding	Quantitative survey, Sava RB interviews and interviews with module leaders
Knowledge integration	Quantitative survey, analytical tool, Sava RB interviews and interviews with module leaders

Table 2, methods employed to measure the variables in this study.

Further explication of the three methods is required to provide an overarching image of the project.
First, quantitative assessment of the available questionnaire data to provide an overview from of the project, see table 3 for the used questionnaire and the number of respondents.

Meeting	**Questionnaire**	**Sample size (N)**
Module meeting in Barcelona, Spain (2014)	1st MM	18
Module meeting in Tubingen, Germany (2016)	2nd MM	27
Module meeting in in Barcelona, Spain (2016)	3rd MM	27
Sampling campaign in Adige river basin (2015)	1st SC	16
Sampling campaign in Sava river basin (2015)	2nd SC	13
General assembly in Athens, Greece (2014)	1st GA	42
General assembly in Munich, Germany (2016)	2nd GA	45
General assembly in Sesimbra, Portugal (2017)	3rd GA	22
General assembly in Belgrade, Serbia (2018)	4th GA	24

Table 3, overview of the available questionnaire data, as composed by the author.

Globaqua is scheduled from February 2014 until January 2019, however the last survey dates from the general assembly in Belgrade 2018. The used data involves a questionnaire that has been filled in by attendees of the Module meetings, Sampling Campaigns and the General Assemblies. The topics were sampled with a questionnaire by using a five-point scale, the questionnaire can be found in Appendix I. Statements could be answered with strongly disagree, somewhat agree, not sure, somewhat agree and strongly agree. These questionnaires have been used throughout the project and are part of WP 12 regarding policy in Globaqua. A selection of relevant topics will be examined to provide a comprehensive overview from start to end. The topics that are relevant for the present study are the scope of IDR, integrative understanding, disciplinary background, work packages, and atmosphere. Significant changes or absence of changes will be reported. There are also questions included regarding the language barrier and to what extent scholars learned from others. These can help to clarify the level of integrative understanding. The overall pictured presented when calculating these variables can help to explicate what level of knowledge integration was achieved and how knowledge integration influences interdisciplinary collaboration. In addition, the qualitative feedback acquired through the questionnaires can help to constitute what factors develop and hamper the development of knowledge integration across disciplines.

Second, two qualitative methods will be used to complement the quantitative findings. First, the output of the project will be scored by an analytical tool developed by the author and colleagues from TNO to analyse articles on their level of disciplinarity. The original version of the analytical tool can be found in the appendix II. Scoring articles is different from previously used forms of measurement since it focusses on output and isn't scored by the authors themselves, whereas the questionnaires involve self-rating and the accompanied bias. Smitaite (2016) shows in her quantitative analysis that IDR has been scored high from the start of the project. By scoring journal articles through an analytical tool it is possible to overcome this self-rating bias. Via the analytical framework presented by van Meerkerk & Slob (2013) three categories have been presented. These three categories serve as the backbone of the analytical tool and have been modified to incorporate statements. First, the scope of IDR whether to assess how much disciplinary insights are incorporated: mono-,

multi- and interdisciplinary Bark et al (2016). As Globaqua is mainly focused on gathering knowledge within the scientific field transdisciplinary research approaches aren't incorporated. Second, indicators for interactive research regarding the domain and integration of tools and methods. Third, the degree of integrative understanding that assess vocabulary used throughout the article. The purpose of the developed analytical tool is to assess the output, that is journal articles, published within the Globaqua project. A total of 134 articles have been published within the Globaqua project so far. Scholars won't be judging their own articles on the degree of disciplinary integration. Scholars fill in whether they agree or disagree with the statements. For the present study three scholars filled in the developed analytical tool: two colleagues from TNO and the author himself. To finalize the findings from the tool a rubric will help to score the answers on the level of interdisciplinarity. Scoring categories will show the level of interdisciplinarity of the scored article. Multidisciplinary findings are the largest category due to their ambivalent nature: they possess qualities of monodisciplinarity and of interdisciplinarity. Each statement can be answered with yes or no, only one yes per category will suffice. The latter was done to avoid ambiguity in the results and create clarity about how it was weighed. When a statement is answered with yes points will be accredited. Only one statement per category can be answered with yes. The scoring rubric serves as a scale, points can be accredited for dimension. Scope, interactive research and integrative understanding an accredited 1-4 points depending on the degree of interdisciplinarity that was achieved. A low or high score does not equal the article did bad or good: a low score corresponds with monodisciplinary or multidisciplinary findings and a high score corresponds with multidisciplinary and interdisciplinary findings. The statements are designed to increase in disciplinarity as one can answer yes on a higher statement. The total aggregate of points will be evaluated to show the interdisciplinarity of the article. Assessment on where an article sits in terms of disciplinarity will be provided. In other words, the aggregate of points serves as a categorization in three scoring categories: monodisciplinary, multidisciplinary and interdisciplinary. A google form is used to acquire the results and provide them in a spreadsheet so the data can be transferred to excel. A general overview regarding a bar chart and percentages per category and statement will be provided.

The second qualitative source of data are telephonic interviews which will be used to explore the collaborative endeavour in twofold. Table 3 shows which respondents were interviewed and provides a description on what role they had throughout Globaqua. The interviewees in table 3 are anonymous, i.e. module leader 1 does not correspond with the actual module leader 1 which can be found in the project description.

Actor	**Current position**
Respondent 1	Laboratory executive
Respondent 2	Researcher in biology
Respondent 3	Researcher in chemistry
Respondent 4	Researcher in chemistry
Module leaders	
Module leader 1	Module leader
Module leader 2	Module leader
Module leader 3	Module leader
Module leader 4	Module leader

Table 3, the interviewed actors involved with the Sava sampling campaign and their current position.

First, the Sava RB will serve as a case study to assess the scoring of the sampling campaign, which respondents assessed as very successful via the questionnaires, also see Smitaite (2016). Examining why they valued their collaboration as successful can help acquire more information regarding interdisciplinary collaborations in EU projects. Second, the collaboration within and between modules will be assessed by interviewing the module leaders to grasp a more general overview. The two cases complement one another: a small scale perspective by interviewees from the Sava RB and a global vantage point via the module leaders.

First, interviewees from the Sava RB contributed to the 134 articles will be interviewed. The Sava RB serves as a case study due to profound collaboration: gathering samples for the sampling campaigns was done by living and conducting research together for two consecutive periods. The qualitative data acquired from the telephonic interviews provides more information about why and how participants experienced the sampling campaigns in the Sava RB. By doing so a coherent image regarding IDR can be constructed, seen from a successful case study.
Second, module leaders can elaborate on the level of knowledge integration within in and cross-module. Questions are similar, however more focus will be executed on the reflection on the overall process and tailor-made questions stemming from secondary data analysis of previous interviews. Two previous rounds of interviews, one in 2014 and one in 2016 will help to constitute an overarching image of the project. Emphasis will be on how the module leaders experienced knowledge integration and how they view the progress of the challenges they’ve framed at the start of Globaqua.

6.1. Reflection on the method – Reliability and Validity

To complete the method it is important to know both the strengths and the limitations of the methods used throughout the present study. By doing so the reader acquires a better view of how the results from the methods should be read. In other words, reflection on the method serves as a guidepost to weigh the sources.
Reliability is about the influence of random mistakes or unsystematic mistakes and precision of the used methods to acquire the data has to be discussed. The reliability of the present study benefits from the multimethod approach to the data, multiple forms of data are used to assess knowledge integration in the project of Globaqua. By acquiring data from multiple interview rounds it is assured that multiple vantage points are assessed. Acquiring data from two different cases adds up to the scope of the research. Both a case study and a general perspective are explored by interviewing respondents from the Sava RB sampling campaign and by interviewing module leaders. These different groups of respondents help to acquire a rich and varied image of the project, making sure the results are rich and incorporate views from different angles. Assessing knowledge integration also profits from the measurement via the analytical tool. The tool is used to surpass self-rater biases. Especially the self-reported variables and the common method bias can be addressed by using the three sources. However, some remarks can be made when viewing the sources. First, the interviews are with a sheer number of respondents, four interviewees for the Sava RB sampling campaign and four module leaders. More interviews, perhaps with the work package leaders could have helped to address this problem. Another hampering effect on the reliability might be that, especially the sampling campaign, suffered from a time gap. The Sava RB sampling campaign is nearly four years ago which could result in a loss of depth in acquiring certain results. Measuring dialogue and trust via the preconditions of atmosphere and informal interaction suffers from a loss of detail as people tend to forget some information. Survey data faces similar problems; a sheer number of respondents filled in the survey over the course of five years. Another hampering effect on the survey data is the differences in the questionnaire, adjustments were made during Globaqua which results in less standardization than one would prefer. When examining the reliability of the tool it shows that differences persist in the way IDR is valued and how much background knowledge is present. The three researchers which weighed the articles differ in disciplinary background and years of experience. In other words, inter-rater reliability shows differences per observer which were mitigated, through discussion and exchange of ideas, to a final score per article. Since the tool is only used to assess articles from Globaqua it is impossible to compare projects with one another. Testing the tool in another project would help to acquire more data and gain more insight in where the tool excels and what adjustments should be made for future use. Further remarks and adaptations of the analytical tool can be found at the start of page 31.

Assessing the validity helps to acquire a sense of how the measure represents the variable that was intended to. When examining the interview questions it shows that especially trust and dialogue were harder to measure. Both concepts cannot be asked directly due to the confirmative answers related to social conventions that are often dispersed. For example: asking a respondent whether he or she felt there was enough trust the answer will, due to social conventions, usually be affirmative. A more subtle approach is required, one that is more indirect by asking how respondents feel about the collaboration in the project and on

what previous endeavours it is based. In other words, processual factors regarding the interaction, setting milestones and project management are vital components to assess the degree of trust and dialogue.

Several items in the questionnaire have been used to complement the present study. To clarify what items have been used a table will be included: presenting what items from the questionnaire are used to measure variables from the present study. Table 4 can be viewed below. Items are operationalized with a differing amount of statements.

Variable	Item in questionnaire, composed of:
Atmosphere	**Atmosphere:** • The atmosphere during the meeting has been comfortable • The other participants were willing to listen to my contributions • There was enough time for discussing ideas with other team members • The meeting helped me to get to know the other participants better • I feel comfortable to show limits or gaps in my knowledge to the other participants
Dialogue	**Open-ended question:** • What have you learned from the collaboration with other disciplines in GLOBAQUA so far?
Time, language and commitment	**Open-ended question:** • What are to your opinion the main challenges in the cooperation between different disciplines in GLOBAQUA so far?
Integrative understanding	**Integrative understanding:** • Up till now, GLOBAQUA helped in developing a common understanding between the disciplines • Up till now, GLOBAQUA helped in developing shared concepts between the disciplines • Up till now, GLOBAQUA helped in developing a shared framework between the disciplines
Knowledge integration	**Interactive research:** • In GLOBAQUA there is a lot of interaction between different disciplines • In GLOBAQUA much time is spend on understanding other disciplines • In GLOBAQUA research methods from different disciplines are integrated • In GLOBAQUA theories and models from different disciplines are integrated **Effectiveness in advancing understanding:** • I think that interdisciplinary research among GLOBAQUA participants will lead to valuable scientific outcomes for river based management that would not have occurred without collaboration • Generally speaking, I believe that the benefits of interdisciplinary research within GLOBAQUA outweigh the inconveniences and costs of such work • GLOBAQUA helped me to learn from other disciplines • GLOBAQUA has improved my understanding of other disciplines • GLOBAQUA has improved my appreciation of other disciplines

Table 4, the left column shows the variables used in this study and the right column shows what items from the questionnaire have been used and which statements they consist of.

The analytical tool has been adjusted, the scoring scale has been adapted. By doing so the variations are lowered and scoring higher statements does not taint the degree of disciplinary integration as much. Different scorers seem to score in a very different manner, years of experience and scientific background are among the core factors that cause high divergence in

scoring. Colleagues from TNO had expertise in natural scientific disciplines and were able to adjust results if differences per scorer occurred. To mitigate the effects of previous experiences the scores have been adapted manually, large differences are reconsidered and adjusted in order to acquire valid conclusions. The latter was done by my colleagues from TNO and based on three factors: their own experience in natural scientific disciplines, how they scored the article themselves and through discussion and exchange of ideas regarding the interdisciplinarity of the score had to be adjusted. By doing so the effects of unintentional errors and fluctuations were mitigated. The latter improves the validity, as it mitigates the differences occurring from the varying scientific background and knowledge of the subject prior to assessing the articles. In other words, the scores of the three scorers have been adapted and a final version which incorporates one score per article has been made. Section 8.2.1. will elaborate on the scores provided for each of the 134 articles.

One of the major adaptations is removing the results from the second category regarding interactive research. Three reasons constitute the latter decision. The three categories can be viewed in table 5, on the page below.
First, interactive research fails to incorporate an increase in interdisciplinarity when a higher statement is answered with yes. The tool is designed to show an increase in disciplinarity when one can answer yes on a higher statement. For example: statement one corresponds with monodisciplinary findings in all three categories, while statement four is interdisciplinary. Statement two and statement three in interactive research are hard to distinguish from one another, as they do not increase in disciplinary integration. In other words, interactive research did not show an incremental increase of disciplinarity per statement while the scope of IDR and indicators for integrative understanding show a gradual increase in disciplinarity per statement.
Second, the scored articles do not describe the process of combining input thoroughly which makes it impossible to measure interactive research based solemnly on a published article. Interactive research cannot be discerned based on the article, authors do not go into detail regarding the process of problem formulation, synthesizing fields of knowledge and how they link fields of knowledge. Undergirding processes that constitute the article are not dispersed in the published form which make them unsuitable for assessment via the category of interactive research.
Three, the category of interactive research also presupposes that multiple researchers or teams of scientists lead to heightened IDR. The latter is not the case, IDR is a process that can spring both from a single mind and from a team endeavor. The distinction between single mind and team endeavor does not represent disciplinary integration in a unilateral way. Making the distinction between mono- or multidisciplinary teams would not help to distinguish the level of disciplinarity, both teams could produce mono- or multidisciplinary findings. Reporting about the team composition doesn’t reveal uniform information about the disciplinary integration. By leaving out one category in the total score reliability is lower, less categories cause the reliability to drop.

1. The scope of IDR	2. Indicators for interactive research	3. Indicators for integrative understanding
S1) The present article only displays contributions from a single academical discipline.	**S1)** Within the present article research is being conducted within mono-disciplinary teams. No other teams or departments contribute to the present article and empirical data, concepts and methodological approaches remain within team boundaries.	**S1)** The present article uses vocabulary, i.e. concepts and language, merely borrowed from a single discipline. An empirical phenomenon is described in a unilateral way, through mono disciplinary language.
S2) The present article displays disciplinary insights from more than one academical discipline. However, these insights are not integrated.	**S2)** The present article shows that multiple teams contribute, yet the domain in which they operate is very much alike. For example cooperation among natural sciences OR among social sciences.	**S2)** The present article uses vocabulary from disciplines that are alike. These concepts are still used for the purpose they are designed for and remain within the contributing disciplines.
S3) The present article synthesizes knowledge from multiple disciplines. Collaboration within the same domain is executed, for example in the domain of natural sciences.	**S3)** The present article shows that multiple teams collaborate and synthesizes or contrasts concepts, models, or theories from more than one field in order to develop new theoretical tools for interdisciplinary analysis. The contributing authors develop an integrated approach. The function of integration is to create links between fields, explore a new field of knowledge, or establish new paradigms. Models, concepts, or theories from more than one field are being used to stimulate integration across domains.	**S3)** The present article uses vocabulary to introduce concepts into a new context, i.e. borrowing concepts from one discipline to use them into another discipline.
S4) The present article combines findings from heterogenous academic disciplines, a combination between natural- and social sciences is used.	**S4)** Have different research steps been interactively undertaken within the article? (problem formulation, framework, method, data collection, analysis and answering the research question)	**S4)** The present article shows that a common vocabulary is established, the concepts forming the basis for the article are used in an integrated manner, a novel vocabulary to describe findings or concepts is used. The present article strives to go beyond the sum of the parts by the preceding concepts.

Table 5, displaying the core categories of the analytical tool, without the answer options of agree and disagree. For the entire analytical tool see Appendix I.

The impact factor has been covered insufficiently for three reasons, see table 6 for the fourth question of the analytical tool regarding the impact factor. First, due to the majority of the articles being published in Science Of The Total Environment (SOTTE) there is little difference between the reported impact factors. The hypothesis that a higher impact factor is linked with monodisciplinary findings cannot be examined thoroughly since nearly halve of the articles have been published in the same journal, SOTTE. In other words, the results are tainted due to the majority of the articles having the same impact factor.
Second, some impact factors could not be retrieved as well and have not been filled in.
Third, there is a lack of uniformity in impact factors, not every impact factor has been calculated over the same period of time, multiple formulas exist. Making calculations based on impact factors of differing formulas does not provide reliable results. In other words, the impact factor is too pluriform since some scores couldn't be found and differences in the calculation of the impact factor are present.

4. Impact factor	The impact factor (IF) is a measure of the frequency with which the average article in a journal has been cited in a particular year. It is used to measure the importance or rank of a journal by calculating the times it's articles are cited, report the impact factor in the adjacent column on the right.	

Table 6, displaying the fourth question from the analytical tool regarding the journal indicators.

6.2. Measuring the conceptual model

Because the process of knowledge integration requires interaction across actors and across disciplines the social interaction between the participants should be addressed. Section 6.2 consists of explanation on the indicators for qualitative interviewing. Indicators for qualitative interviewing are designed for the present study and require a brief explanation before the concepts are operationalized in table 7 on page 37-39.

The qualitative interview will help to gain three core objectives.
First, to provide a case study that builds further upon the results gathered thus far. Actual feedback from the field on the collaboration in the Sava RB will be gathered and help to explore why they value their collaboration as very successful. Qualitative feedback will help to gather profound knowledge on what meaning participants give to the project and how they feel about knowledge integration.
Second, the qualitative feedback can help to test the literature mentioned in the theoretical framework. Guiding is the conceptual model and the corresponding concepts. These will be questioned in a comprehensive manner. First, assessing dialogue through investigating how participants established and managed goals among each other. The concept of dialogue can assist in understanding what actors require from one another and jointly explore difficulties and openness to one another's frame (Isaacs, 1993, 1999, 2001). Second, assessing the levels of trust through the guideposts provided by Lewicki & Bunkers (1995, 1996). Central is the source of trust and, predictability, vouching for and representing another's needs.
Third, integrative understanding. Examining whether participants were able to work together with varying disciplinary insights and establish a common vocabulary. Fourth, the factors that influence collaborative endeavours. The focus is on time, language and commitment (Kragt et al. 2016, Bruce et al. 2004, Trussell et al. 2017). The qualitative interviews can assist in providing guideposts for future research and to expand on the vast amount of literature regarding IDR. The dimensions of dialogue and trust are operationalised in a table and can be viewed in table 7 on the next page. Incorporated in the table are indicators operationalised via high or low degree of the corresponding theory.

Table 7, Operationalization for the qualitative interviews.

Dimension	**Definition**	**Indicators and example questions**
1. Level of Dialogue	• Dialogue is about exploring the perspectives of other's methods and exploring approaches used by the participants. Group composition, whom decides what should be done and if participants know one another are decisive factors for the degree of dialogue (Isaacs, 2001).	• Did the participants collaborate with one another in the past? • How did participants cope with novel, unfamiliar ideas (i.e. framework or combining insights from natural- and social sciences)? How did participants establish goals with each other? Low level = disagreement among participants Intermediate level = why assumptions persist occurs, but a novel framework isn't achieved High level = discussing assumptions across disciplines to reach agreement over a novel frame
2. Level of Trust	• Trust refers to a trustors estimation of the probability that preferred or expected behaviour occurs (Moyson et al. 2016). Trust is not a linear process, it builds up incrementally through previous behaviour (Lewicki & Bunker, 1996). When understanding how trust can be fostered insight in how relationships change, grow and decline is gathered (Lewicki & Bunkers, 1995).	• Were participants able to know one another sufficiently well, were they able to predict behavior at a level of certainty? • Were participants able to commit to commonly shared values? And were they able to represent other's needs and serve as a substitute? • Will participants collaborate with one another in the future? Low level = low predictability, not wanting to cooperate in the future intermediate level = being able to anticipate on the other's behavior due to knowing one another High level = representing other's needs and predicting what others would do

3. Level of Integrative understanding	• Integrative understanding is about collaboration and interaction between individuals who speak different disciplinary languages. A important assessment criterion is the degree to which collaborating parties are able to come to a shared understanding of the empirical phenomenon. A major indicator is the development of 'a common language' for the realization of integrative understanding (van Meerkerk & Slob, 2013).	• Were participants able to work together with varying disciplinary insights? Were they able to develop a common meaning and synchronize between actors? • Did participants develop a common vocabulary or share language? • How did participants coordinate results? Low level = separate frameworks Intermediate level = Some concepts are incorporated but are not integrated into a new common language High level = integrated frameworks
4. Time	• Interdisciplinary teams require additional time to acquire joint understanding of research questions, concepts and communicate about expectations between actors (Kragt et al. 2016). Coping with the demand of time is done by organising meetings prior to the funding of the project to develop a shared vision about goals, objectives and to align expectations (Kragt et al. 2016). Part of aligning insights is including space for 'social time' (Bruce et al. 2004).	• Do you think there was enough time to conduct the research and align objectives and goals together? Low level = lack of time and little communication to develop a shared meaning prior to the project start Intermediate level = Time pressure is felt and little social time is incorporated, hampering further integration High level = Incorporating social time and developing shared meaning through meetings prior to the project.
5. Language	• Disciplines have their own specific jargon, which can be hard to comprehend by other disciplines. Disciplinary jargon complicates discussion between team members of different disciplines, especially at early project stages when team members are still unfamiliar with one another (Kragt et al. 2016).	• Were participants able to understand language used in contributions from other disciplines (use of jargon)? Low level = misunderstandings by use of jargon that wasn't explained in a proper manner Intermediate level = jargon is discussed, but it takes time to get to know each other's jargon High level = jargon was explained in a proper manner so group members could understand

6. Commitment	• Team members need to be actively engaged and committed to the process (Trussell et al. 2017). An essential element of commitment is the willingness of team members to engage in the process, wanting to actively contribute to interdisciplinary research and invest in getting to know unfamiliar research practices (Trussell et al. 2017).	• Were participants able to deliver consistent and sufficient effort (commitment)? Low level = lack of commitment and a lack of eagerness and willingness to invest into unknown research practices Intermediate level = heightened willingness to get to know unfamiliar research practices • High level = lots of commitment and effort throughout the collaborative process to explore disciplinary bias and to create novel research synergies
7. Level of Knowledge integration	• The interdisciplinary character of a research should be assessed on the basis of how the fields are represented and their relation with the conducted research. Overarching is to what extent the researchers themselves experience that the collaboration across fields requires a special epistemic challenge: combining components from different fields of research with one another (Huutoniemi et al. 2010).	• Were participants able to develop a conjoint framework, collect and analyze data together? • In hindsight on the project, how do participants think about working with different disciplines throughout Globaqua? • Do you think the present results could not have been established with a mono-disciplinary approach? low level = not being able to collect and analyze data together, results would have been possible through monodisciplinary approach Intermediate level = Data is collected together, but is still bound to disciplinary demarcation High level = analyzing and collecting data together, results only possible through combined disciplinary insights

7.Case introduction: Globaqua and the Sava

The case to derive empirical findings from is that of Globaqua. The project started in February 2014 and will run until January 2019. Globaqua is a EU funded project that manages the effects of multiple stressors on aquatic ecosystems with water scarcity. Eu funding and goals are regulated through the EU water Framework Directive (WFD) by the European Council (2000). The WFD provides a legal framework to ensure community action in the field of water policy (European Council, 2000). Understanding and integrating aspects of the water environment in an effective and sustainable way is one of the main goals of the directive (Voulvoulis et al. 2017). Core objective is the protection of European waters in order for Member states to reach standardised objectives for water bodies throughout the EU (Voulvoulis et al. 2017). WFD was adopted as successor of more traditional management practices which focussed on command and control. By replacing and shifting the paradigm the focus was no longer on managing individual non-compliant components. Emphasis shifted from administrative borders towards water management by hydrological catchments (Hering et al. 2010). The pursued overarching goal is improving the quality of surface water bodies. The WFD is shaped along management cycles recurring in 2015, 2021 and 2027. What the WFD requires is a catchment-based approach: management of land and water seen as a systems approach (Voulvoulis et al. 2017). In other words, a catchment-based approach is emphasized and the water environment is seen as an adaptive system. This approach integrates various insights through a holistic view. The so called catchment-based approach is composed of interdependent human- and natural systems. Problematic about this approach is that defining, selecting and appointing the salient features is prone to individual differences regarding measurement (Voulvoulis et al. 2017). No consistent biological datasets were generally available for lakes, rivers and coastal waters and standardisation is pursued (Hering et al. 2010). However, those monitoring the aforementioned bodies of water were not always willing to change their former practices. Old practices of measurement, used before the WFD (2000), were not compliant with the directive. These systems were not reference-based, they did not assess deviation from an baseline (Hering et al. 2010). Different frames cause an ambiguity of views. In other words, framing what is important for the catchment encompasses a rich variety of views that show much individual differences in terms of measurement.

Globaqua focusses on the joint occurrence of multiple stressors on aquatic ecosystems (Globaqua, 2018). Interaction among stressors is the primary focus of this project, and therefore the project is structured through a multitude of disciplines and actors. A wide variety of scholars, policymakers and other stakeholders are involved in Globaqua (Globaqua, 2018). Assessment through this standardised and catchment-based approach should eventually serve as a guidepost for restoration needs and measures (Hering et al. 2010). The directive allows for measuring stressors within their given context, as sensitivity and resilience to pollution might vary across ecosystems (Hering et al. 2010). Regarding this adaptive approach provides the basis for management decisions that are specifically aimed at the designated body of water. Globaqua is structured through the Description Of Work (DOW, 2013). Globaqua is divided into work packages ranging from 1 to 14. Work packages differ in what they are responsible for, ranging from gathering data regarding water quality to policy implementation. The lower part (1-7) is predominantly natural sciences and the higher part (7-14) focusses more on implications and policies and is inquired through social sciences. Note that mixing of

responsibilities occurs throughout Globaqua: the demarcation is no clear watershed. Predominant is the focus on scientific disciplines regarding water measurement such as hydrology, geomorphology, chemistry and biology. The main objective of Globaqua is summarized in the DOW (2013) as follows:

By seeking the understanding of stressors interactions, species interactions, species-stressor-relationships and impacts on the ecological functioning, stability and resilience of the aquatic ecosystems in order to implement water policy and optimal decision making in water resources management under complex multiple stress conditions. (part B, p 2).

To provide a better overview of what is done in the project figure 1 displays a flow chart of the modules and corresponding work-packages. Interaction among work packages can also be seen in the flow chart.

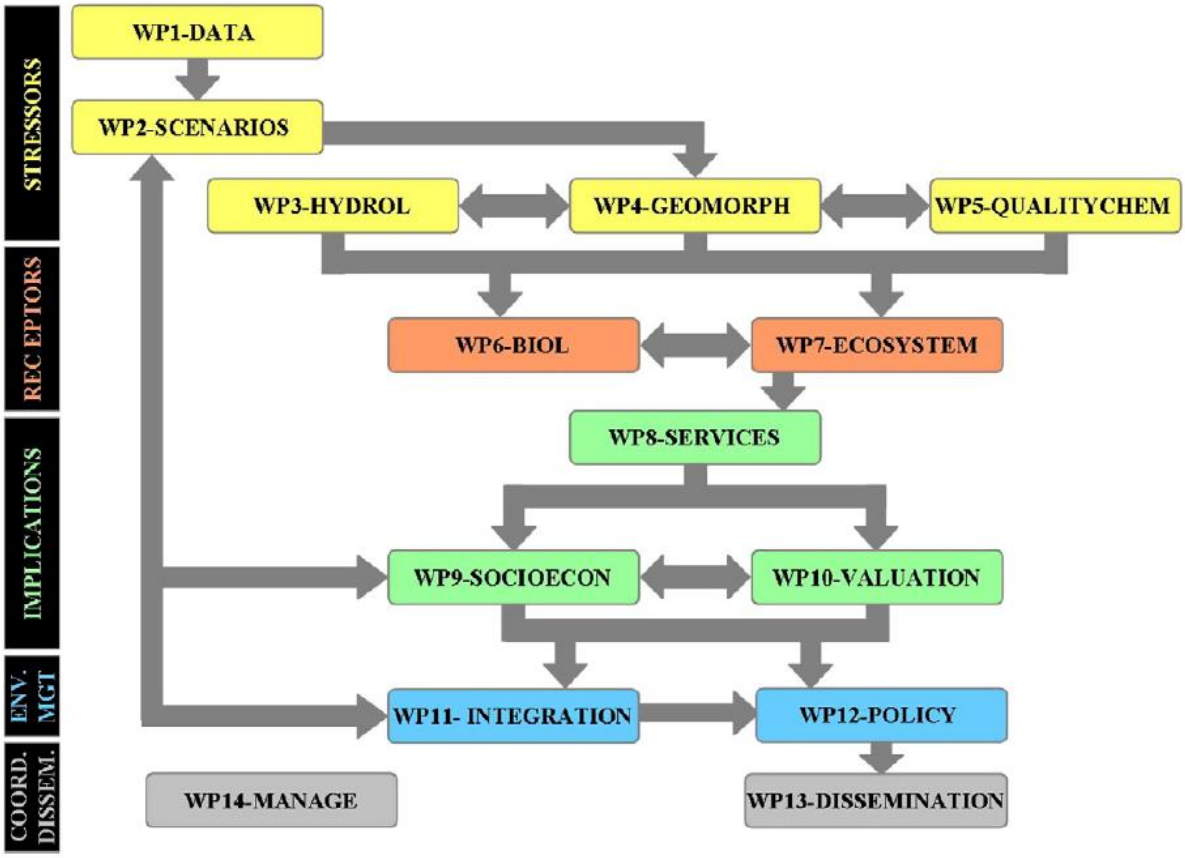


Figure 1. Module and work-package structure of Globaqua. Source: Navarra-Ortega et al. (2014).

Throughout Globaqua six river basins are studied: Ebro, Adige, Sava, Evrotas, Anglian and Sous Massa. All these river basins are affected by water scarcity and the interaction with existing stressors in the river basins is examined (Navarra-Ortega et al. 2014).

For our current purpose the Sava River Basin (Sava RB) is examined. Four scholars were interviewed to acquire more information regarding the Sava case and they are summarized in table 3

. Flowing in six countries, Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Albania and Montenegro, the Sava is the only river in Globaqua that crosses six borders. Sava RB is a

major drainage basin of South Eastern Europe with a total area of 97,713.20km2 (SRBMP, 2014). WFD provides the guideposts for the Sava RB. Conducting research in the Sava RB is done in a simultaneous sampling campaign. These field campaigns were performed in the same period of the year: both spring/summer conditions and fall / winter conditions. In other words, both the dry year and the wet year were examined in a consecutive period over two years (DOW, 2013).
If we take a closer look at figure 1; these sampling campaigns were performed by WP 4, 5, 6 and 7. To sum up, scholars responsible for the Sava RB are predominantly focussed on identifying stressors and receptors. Therefore the Sava RB is mostly focussed on natural sciences. The dominant focus was the conjoint research for biology and chemistry.
Several severe pressures on the Sava have been discovered such as the consequences of the military operations in early 90s. Unexploded army materials can pose a threat for the river environment (SRBMP, 2014). Especially dangerous is that the location and quantity of these materials are unknown and demining has to be accounted for. In addition to military activity pollution of the environment caused by industrial wastewater has also been an influential factor.

8. Results

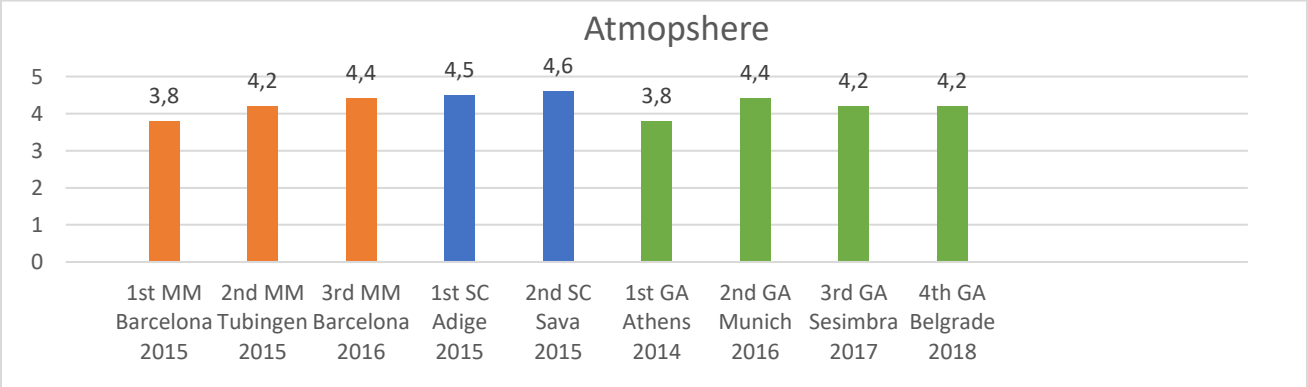
The results section will display the results regarding atmosphere, open-mindedness, formal and informal interaction, trust, dialogue, time, language and commitment, integrative understanding, and knowledge integration. For a short recap see section 8.8 where all the individual parts are linked together in an explicit manner.
A multimethod approach will help to attain a coherent image of the project. Both a global impression provided by the questionnaire as well as in-depth information acquired through the interviews and journal articles scored via the analytical tool are presented. The questionnaire will be used to provide a more general overview, which is supplemented by data from the analytical tool and interviews. A synthesis will be presented at the end of each variable to summarize the most important findings.

8.1. Atmosphere and open-mindedness

Examining open-mindedness and atmosphere will be done by using data gathered via the questionnaire. These concepts form the guideposts for a fruitful dialogue due to the exchange of wants, preferences and held assumptions and are factors related to the degree of dialogue. Since trusting one another depends on knowing what one wants, and is based on previous interactions atmosphere and open-mindedness contribute to the degree of trust as well. Mean scores of atmosphere throughout Globaqua meetings will serve as a vantage point and will be complemented with findings from interviews and open ended questions stemming from the questionnaire.

Forming an image of what other participants in the project can contribute is an essential part of collaboration and a constituent of a fruitful collaboration. Through dialogue scholars were able to get to know predispositions, assumptions and beliefs undergirding research. Atmosphere and open mindedness serve as building blocks, the foundation of dialogue. Assessing their level is done to determine whether a dialogue was even possible within the cooperation. When atmosphere and open mindedness are present to a low degree it becomes very hard to discuss assumptions and create novel things in relationship to one another, and therefore the degree of both atmosphere and open mindedness will be determined.

Assessing atmosphere and open-mindedness begins by examining the category atmosphere via the questionnaire. Doing so serves as a starting point to determine if participants were able to know the perspectives of other's and think in relationship. The atmosphere has been sampled throughout Globaqua on multiple occasions via the survey on knowledge integration: in the general assembly, module meetings and in the sampling campaigns. Graph 1 shows the overall trend regarding atmosphere throughout Globaqua. Atmosphere has been sampled through five statements that could be answered with strongly disagree, somewhat disagree, not sure, somewhat agree and strongly agree. The below mentioned graph shows high levels of satisfaction with the atmosphere throughout all the meetings, as the mean score varies between somewhat agree and strongly agree. The below mentioned graph shows results on statements regarding the atmosphere: being comfortable, if other participants were willing to listen to one's contributions, if there was enough time for discussing ideas with other team members, getting to know the other participants better and being able to show limits or gaps in one's own knowledge.



Graph 1, as composed by the author. The mean of atmosphere throughout Globaqua meetings.

Researchers tend to value these statements with very high scores as the project progresses. Scores during the 1st MM and the 1st GA tend to be a little bit lower and these mean scores tend to increase over the years with 0,4 to 0,5 points. Findings from the interviewees complement this view when examining open mindedness. The interviewees stated that collaborating with various disciplines requires an open attitude and an atmosphere that allows for testing other's assumptions. As one of the scholars from the 1st GA summarizes open mindedness:

The main challenge we have as a group is to be open-minded enough to truly do interdisciplinary science.

Findings from the Sava RB sampling campaign

Openness to limits or gaps in knowledge and listening to contributions from others was also emphasized in the results of the case study of the Sava RB sampling campaign. The below mentioned citation serves to illustrate the atmosphere and open mindedness to learning that respondent 2, researcher in biology, experienced:

Even the people who are very advanced scientists in their own disciplines were very interested to learn from other people. They were very nice to learn. Some people stopped learning when they are far in their career, for some of us it is important to learn from the end of their career. Without any shaming, people were open to ask and discuss the issues, it was very nice.

Conclusion

It is shown that atmosphere and open-mindedness were present throughout Globaqua. The questionnaire displays high means on atmosphere, which implies that the willingness to listen and being comfortable within a group are present. When examining findings from the interviews it shows that the willingness to participate in interdisciplinary science and the importance of learning from one another are emphasized. It seems respondents are well aware of constituting factors of collaboration. Starting conditions for dialogue and trust are present, being comfortable regarding the group atmosphere and willing to learn and listen from one another via open mindedness.

8.2. Formal and informal interaction

Interaction is the core guidepost for both dialogue and trust as a precondition for relationship building. For the purpose of Globaqua it is fruitful to reflect on the interaction that occurred throughout the project. By doing so the outlines of dialogue and trust can be captured. Assessment of interviews with module leaders helps to acquire how module leaders view interaction throughout Globaqua. Both formal- and informal interaction will be discussed to view the communicative endeavour. Interaction is explicated in twofold. First, assessing the formal interaction that occurred in Globaqua by reflecting on the official project meetings such as the general assembly, module meetings and the sampling campaigns. Second, findings regarding informal interaction are discussed. As module leaders mostly emphasized face to face meetings and stated that e-conferences and mail contact were a minor contribution to interaction these will not be addressed any further, and therefore the main focus relies on official project meetings and the effectiveness of informal activities/interaction.

Module leaders mention there are differences in the official project meetings when it comes to bolstering integration. In general they emphasize the collaboration within the module meetings and the sampling campaigns, especially how they helped to foster knowledge integration and increased cooperation. Module leaders emphasize setting the stage at module meetings, as module leader 3 emphasizes:

But work wise, where do we make the most progress, and where do we set the building blocks fundament for the further work, that is really being done at the Module meetings. But I think, in terms of interdisciplinarity and the common vision of the project, Module leader meetings may be most useful.

Module meetings helped to constitute the tasks of modules and knowing better what others were trying to accomplish. However, they agreed that the interval at which the module meetings were held should be increased in order to achieve a more profound collaboration. When examining the general assemblies a fundamentally different image persists. Meetings were judged as being ineffective when it comes to increasing the collaboration. One core reason persists throughout these interviews: the limiting potential of general assemblies due to their design and how they were used by the participants. General assemblies were used to report on the findings and activities pursued by each module. Module leaders served as a representative to report on the findings within the module. According to several module leaders this caused self-contained projects and heightened demarcation between modules. Currently the general assemblies served as a tool to present the findings from the different modules and agreement among module leaders persists that these meetings should be hosted in a different manner were dispersed. In addition to the reportive nature module leaders stated that days were filled with presentations in a very tight schedule, which left little room for integration or reflection on the process to foster knowledge integration. Module leader 3 and 4 emphasize the limitations of the way general assemblies were hosted:

I can tell you where I see the biggest problem. I think at the general assemblies in particular. When everybody gathered they were always too short. Much too short in my opinion. In a way they were organised. We met and we had sometimes very lengthy presentations. Each of the presenters see where the links are (module leader 3).

They were not even there to inform anybody else in terms of how their work needs to change for this integration to happen. Whenever this happens it became a conflict or a disagreement. Even what looks like organising these meetings are supposed to be helping the tools, they were not designed for that. They were not encouraging discussion, they were not challenging people's views, they were just there to report back (module leader module leader 3).

It is also, the meetings are very short. Sometimes I feel that some questions that really help the integration process fell short. Everybody was consenting; this is my contribution (module leader 4).

The abovementioned quotes emphasize problems with the design when it comes down to fostering integration between different modules, scientific disciplines and held opinions. General assemblies being focussed on effectiveness might have backfired: due to the tight schedules and high number of presentations the effectiveness was reduced. When examining the notes from the GA's this image is endorsed, participants were showing little interest as the day progresses, and were getting annoyed when the presentation took longer or when extensive questions were addressed. The latter can be seen when attention diminished and signs of agitation when assumptions were questioned in length.
When asked about the role of informal meetings module leaders emphasize that these might be more beneficial, especially the sampling campaigns were mentioned as an example of increased collaboration due to the fact that scholars were together for an extended period of time. The sampling campaigns served as a guidepost for collaboration in module 1 and module 2 of the project, whereas module 3, 4 and 5 were not incorporated in a similar scheme. Module leaders from module 3,4 and 5 emphasize that their activities were less prone to the influence of informal interaction, which did shape the collaboration for the researchers in module 1 and module 2. One of the module leaders also emphasized that informal meetings can also serve to enforce existing ties, to those whom we already know and feel comfortable collaborating with.

Formal- and informal interaction are vital constituents for both dialogue and trust. The degree seems to differ throughout Globaqua, whereas module meetings were emphasized to foster integration, general assemblies suffer from flaws by design and the sampling campaigns blossomed through informal interaction. Especially the lengthy reportive nature caused discomfort among the participants. Integration was hampered by the inability to address questions and the tight schedule that was developed for these meetings. Sampling campaigns were once more addressed as fostering integration. The latter consists of integration within module 1 and module 2 of Globaqua, steps in integration between natural sciences for biological and chemical disciplines were attained. Informal meetings can reinforce existing ties to those whom scientists are already familiar with and were a vital part of the collaboration in the Sava RB sampling campaign. Time to live together for an extended period of field research did not occur in module 3, 4 and 5, and therefore their interaction was based in official project meetings. In other words, differences persist per module how they organised their work and if that incorporated informal interaction or they rely more on the formal project meetings.

8.3. Trust – working relationships explicated

Together with dialogue trust is one of the prerequisites to communicate (unfamiliar) findings and integration of concepts and ideas. Trust revolves around expected behaviour occurring and is an incremental process based on past interactions (Lewicki & Bunkers, 1995, 1996). Trust will be explicated via two cases within Globaqua, on a small scale and seen from a more general perspective. First, interviewees from the Sava RB sampling campaign will elaborate on their findings regarding the working relationships. The Sava RB sampling campaign serves as case study on a small scale. Special attention will be paid to the extensive character of the sampling campaign via the effects of the informal activities. Second, to acquire a comprehensive image findings on a global level are presented by interview data acquired from the module leaders. The level of trust will be explicated via the indicators, especially the levels elaborated as indicating questions.

Findings from the Sava RB sampling campaign

The Sava RB sampling campaign consists mainly of the joint fieldwork between the Jozef Stefan Institute and the Sinisa Stankovic Institute. Both institutes have been conducting research in the Sava RB for more than a decade. Interviewees from both institutes stated they knew each other from these previous collaborations and know what to expect from one another. They complement one another: together they know much about both the upper- and the lower stream of the Sava RB. One of the reasons they engaged in Globaqua were previous experiences from working together. Interviewees stressed they knew that the other would keep promises and communicate on a regular basis to finish project deadlines and articles. Throughout the sampling campaigns people were actively engaged in fieldwork for a period of 10 days, covering both the dry- and wet season in two following years. One of the chemists involved in fieldwork during 2014, emphasizes the relationship building during this period:

We weren't only together on the sampling site but also for the lunches and evening so we talked about everything. And also it helped a lot that we connected more and knew each other more so the environment was really relaxing and friendly.

The social aspect after doing the fieldwork helped them to connect and to acquire more information about the wants, preferences and approaches to project-related goals problems. In other words, this helped to constitute the sought after courtship that is required for knowledge-based-trust. As previous collaborations shaped the collaboration, the fear of deterrence is not an decisive factor. The collaboration via Globaqua isn't totally novel, as the main actors know one another from past projects. In other words, the fear of a sanction when violating another one's trust does not represent the stage this collaboration is in. Previous collaborations were both valued as fruitful collaborations, and therefore engaging in another collaboration wasn't estimates as a risky endeavour. To sum up, calculus-based-trust does not apply to the Sava RB since scholars are acquainted with one another due to collaborations in the past. Knowledge-based-trust is achieved; anticipating on behaviour presented by the other. Information is acquired through previous collaborations and getting to know one another through regular communication. Respondent 2 characterizes the collaboration between biologists and chemists and the earlier experiences that shape the level of trust:

Confidence is very important; I know that respondent 1 will work perfectly. When you first work with someone it is trying out how to communicate with one person. And what the person reports on time, that kind of issues... The respondent communicates very well, maybe that is the most important part during the collaboration.

The collaboration in the Sava RB between the institutes was anticipated to be positive based on earlier endeavours. As the abovementioned quote shows the predictability of the other's behaviour within the collaboration was heightened due to clear communication. The collaboration within the Sava case does show some processes required for identification-based-trust, the sampling protocol can serve as a guidepost to appreciate and understand what the involved parties want. However, evolution on a more personal level isn't present, actors rarely see each other in private endeavours. Core exception on the latter is the informal activities accompanying the sampling campaign: eating together, residing at the same accommodation and travelling to institutes with the samples. The collaboration is work related in order to acquire and produce results for Globaqua. Fieldwork done for the Sava RB sampling campaign did not evolve towards identification-based-trust due to the monitoring and surveillance of the project and the output that persisted. Actors were monitored by their work package and module leaders. Interests for output can differ: they are aware of each other's interests but due to the highly complex nature they are unable to vouch for the other's interests completely, biology and chemistry are two very different disciplines in terms of scale, output and pursued sampling methods. This can be seen when interviews explicated the clear demarcation of responsibilities when it comes to the sampling protocol: biologists were responsible for the biological part and chemists for the chemistry. Often researchers in the Sava RB sampling campaign have experience in either of the two disciplines, not both. That is why they were unable to comment or deliver suggestions to alter the sampling protocol due to their lack of expertise to do so.

Findings from module leaders

Seen on a more global level the module leaders emphasize that much participants know each other from previous European projects and are experts in their own discipline. The level of trust is influenced by project goals and milestones, as module leaders tried to reach their own module-based goals. Module leaders state that scientists work with one another and with project partners over several years, and thereby getting more familiar with interdisciplinary projects. Getting to know one another, and being able to represent other's needs is obstructed due to the aggregate of different expertise, and is summarized in the quote below by module leader 1:

Well this is a constant thing in interdisciplinary projects, but even in disciplinary research projects; this is the idea, you work on things you didn't work on before. And given your background you are able to understand most of it... And given your background you can understand it but you cannot work. For example, I cannot really work on chemical issues; but I can work on climate change scenario issues, even when I'm not an physicist.

The abovementioned quote shows that representing needs of other's and serving as a substitute can only happen on a superficial level, participants face difficulties regarding expertise they do not possess. Being an agent for the other, substituting, is impeded by the discipline specific knowledge that is present throughout Globaqua. Profound knowledge is required to produce in a specific field. Anticipation of behaviour is to be expected: through

project demands such as milestones and deliverables in combination with experiences from previous collaborations one is able to predict behaviour sufficiently well. The latter results in knowledge-based trust, exceeding the calculus-based trust. Since most project researchers know one another from previous endeavours they are able to assure a certain degree of consistency in behaviour: other's will keep promises. Due to the limitations presented when it comes to substituting for each other identification-based trust is hard to achieve.

When viewed from both a small- and a large scale one can witness issues that hamper the development of trust into the next level: due to the disciplinary expertise it is hard to substitute for each other. The major difference between the two levels of scale is the interaction that occurred on informal basis within the Sava RB sampling campaign. The general perspective didn't host a lot of these meetings, they were primarily focussed on official project meetings. These tend to be in between calculus-based-trust and knowledge-based-trust since some actors might not know one another and they depend on the official project milestones and deadlines to anticipate on behaviour. Informal interaction helped to constitute a better image of the research at hand and getting to know each other better which also contributed to the research. Knowledge-based-trust isn't exceeded as working relationships tend to stabilize at this level. Serving as a substitute and identifying with each other via identification-based-trust requires additional time and effort on top of the knowledge-based-trust that is already present.

8.4. Dialogue – different levels throughout the project

Dialogue serves as a disposition, based on profound listening and speaking to each other as a vehicle to achieve integrative understanding. Inquiry into the know-how of others, getting to know the perspectives of other's methods, scope, approaches and why certain approaches are valued. Dialogue will be explicated in threefold, focussing on the case study of the Sava RB sampling campaign, experiences from module leaders viewed from a general perspective and an example that characterizes the collaboration.

First, the process behind the sampling protocol and how it fits in dialogue will be elaborated upon through the interviews with respondents form the Sava RB sampling campaign. Assessing the process is done by inquiring into how participants cope with novel, unfamiliar ideas and how they established goals together. Gathering more information about how participants perceived establishing goals together helps to gain more insight in the level of dialogue.
Second, during the first module meeting some participants opted for a market mechanism to achieve profound collaboration and was unable to fulfil his idea. The latter serves as an example of dialogue on global scale, an example of how participants cope with novel unfamiliar ideas. In addition to the market mechanism notes of other meetings will be assessed as well to grasp how the process of dialogue occurred and in which participants attempted to increase collaboration between one another.

Findings from the Sava RB sampling campaign

However, researchers are limited to the deadlines presented throughout the project: they are responsible for publishing outcomes within a strict timeframe. The presented case study of the Sava RB sampling campaign shows that natural scientists use a strict protocol which provides instructions for sample identification, handling, preservation and transport. This so called sampling protocol serves as a guidepost on how to study certain samples and provides elaboration on how to standardize these procedures. Standardization is two-sided when it comes to dialogue. First, standardization could hamper a flourishing dialogue, as unencumbered exchange could be bound by the delimitations presented by a strict protocol. The major contributing disciplines in the Sava sampling campaign were biology and chemistry.
Second, standardization also served as a way to constitute a research proposal and provide guidelines for a highly specialized research. Respondent 1 and 2 describe how the sampling protocol works and characterize the most important traits:

Actually we all worked on the protocols. I worked on biology and respondent 1 worked on the chemistry and other parameters. We also put some protocols for hydrology, mainly based on the European standards. Not too many changes in this regard. Chemistry and biology was very important to describe in detail. To make data comprehensible, not only from the Sava but also data from other basins.

Yes, I coordinated the work from the office here. I should tell you that when this started, before the sampling campaign we provided a document on exact sampling protocols. How to sample, water, biota, how to preserve and treat the sample. Everything was within the consortium. I started with biologists and when we made a frame and I send it to other

colleagues. Before we started, we had an exact plan to which points we go and why to that points. How we were organised, how we transported them. It was also in our sampling protocol. It was marked. So you put on this; just fill the sample name, data and how it was sampled. In addition there was also a file in what sample. Everything was planned in advance.

Structuring the sampling protocol was done through extensive contact via project meetings, mail, skype sessions and meetings within institutes. The respondents from the Sava RB sampling campaign emphasized that disciplinary demarcation persisted, although working on a conjoint project, they were responsible for their own disciplines when compiling the sampling protocol. Researchers that were quite novel in the field stated that they had little influence on the formation of the sampling protocol. More experienced researchers had more influence and were guiding in the formation of the sampling protocol. However, differences in how to conduct research and via what guideposts persist . Some disciplines organised within module 1 and module 2 (stressors and receptors) benefit from structure provided by the sampling protocol. Research design from other disciplines such as module 3 and module 4 (implications and environmental integration) require other input to fulfil their tasks. More dynamic approaches are used to acquire the data they need.

Findings from module leaders

When viewing the level of dialogue from a more general perspective via the module leaders it seems two problems are evident: problems of scale and the extent of collaboration that is required to produce results. First, the differences regarding the scale on which a discipline operates. Respondents stated it can be hard to align the scale that disciplines use to gather their data on. Module leader 2 summarizes aligning scales as follows:

For example when we work in Adige and Sava we have data coming from seven or ten sites. In the cases we have to model social-economical scenarios you need to apply the effects of change of economical scenarios. You need to have hundreds of data for this basin. You need to know how change. You need a lot of data in various smaller scale but hundreds of that in order to make the models work well. This is the limit that we have found in Globaqua.

Combining insights gets complicated when one cannot agree on the scale and scope that should be pursued when conducting research. The latter can cause disagreement among participants and cause a divide between disciplines. As the abovementioned quote shows there is also a lot of variety between quantity of data and on what scale it can be acquired. Second, the extent of collaboration that is required to attain the data one needs to constitute their studies. One of the module leaders stated that it varies a lot between disciplines to what extent they are able to operate in a solipsistic manner: chemists can rely on the data they can acquire themselves and need to interact to a lesser extent than scientists that are responsible for the policy outcomes. The latter need a lot of interaction, feedback and input from other participants in Globaqua to acquire a comprehensive image of the state of the project. A diverge between incentives persists, as some scientists choose individualistic approaches over more interactive ones. Preventing this fragmentation has been done by trying to implement a market mechanism in early stages of the project. Module leader 3 describes the market mechanism as follows:

But what I think we should have and could have done is to try to decide and then comply with a joint-description of a market place concept. Let's say where my fellow module leader could answer my scientific question I need these pieces of information from whomever, I don't know who that expert might be so I put a query on the market place. And then everybody does that, and then of all a sudden you have a network of questions and then you can see if somebody is an expert in your domain that could potentially answer your question.

The proposed market mechanism was presented during the first module meeting and did not receive very much enthusiasm within Globaqua, and therefore the mechanism wasn't adopted. The market mechanism was intended to increase collaboration among participants by acquiring more visibility regarding the topics and issues participants were dealing with. Engaging in a query among participants means heightened investment of time and effort to create visibility among partners. Module leaders speculated the query wasn't adopted due to differences regarding to what extent more collaboration should be achieved and that the added value could not be shown in advance of this attempt to create an environment where goals are established and assumptions are discussed across disciplines.

Examining the general perspective can be complemented by assessing notes from multiple meetings. The kick-off of the project described the wish to find more interaction between work packages, and acquiring a comprehensive image of where interests can be aligned (Globaqua, 2014). Constituting a clear link is mentioned by several participants of the project. However, participants seem to blend their own agenda with collaboration in the project. One of the participants summarized his feelings about Globaqua (2014) as a project that incorporates researchers with amazing capacities but tuning up the orchestra is a challenge. The below mentioned quotes illustrate the differing interests from three anonymous participants (Globaqua, 2014):

We also need clear instructions about how to calculate the mass balances.

It must be stressed that communication between WPs right now is even more important than communication within WPs. Otherwise modellers cannot build their models beyond water quantity.

For the first year, for instance, we need a broad sampling scheme, to detect where do the microcontaminants occur. Once we know this, we can make more specific studies to analyse their behaviour.

Notes from the integration session in 2016 complement this view. The intention to increase collaboration between work packages and modules was catalysed via a proactive workshop. During the workshop the model dispersed by Navarra-Ortega et al. (2014) was depicted and participants were asked how they would like to increase collaboration by attaching post-it's on the figure which were later on discussed plenary. Post-its served as guideposts to make appointments between work packages to increase collaboration. What all these meetings have in common is the vantage point to create more connection, how to accomplish this goal differs. What stands out are various examples that include language which revolves around connecting with one another: links with policy, selection of indicators which are not confined to being understandable for a small group, integrating scenarios, integrating models and more (Globaqua, 2016). As Globaqua progresses another meeting was hosted in Sesimbra which included a session to foster integration (Globaqua, 2017). The notes from Sesimbra show that participants have very different ideas on how integration should be fostered, they struggle to

find the appropriate means to connect and no one is responsible for the process of knowledge integration. Due to the multiple attempts at increasing ties across work packages it shows that the intention to foster collaboration is present. The employed measures were different and guided in various ways. A lack of uniformity persists, which could be attributed to a low degree of monitoring the process. The intention was there, but the form and guidance to do so show variation.

What we see here is disagreement among participants of the project to what extent collaboration should occur. Perhaps the lack of an uniform approach to increase collaboration also contributed to the lack of effectivity of the used measures. Multiple approaches, that is workshops accompanied by instruments, were used to foster integration between work packages. Assumptions persist and a novel framework to undergird interdisciplinary research and connecting more ties between modules was not achieved. A more individualistic approach was pursued; connection within modules and less cross-module. Due to the individualism and disagreement over what framework should be committed to the level of dialogue on a global scale is in between a low level and an intermediate level. The latter is also shaped by differences within Globaqua, as a fruitful dialogue about how the sampling protocol should be drafted was vital for later parts of the project.

A low degree of dialogue can be seen elsewhere: as demands were not always applicable to a rigid design prior to the actual research. An example can be seen in module 4 regarding the policy, such as the level of knowledge integration. Shaping this research is easier when the project has ran for a couple of months, or even years: actors are able to reflect on cooperating together and know which meetings were essential and which were less able to serve as building blocks for knowledge integration. Once more the overall score shows differences when examining modules individually. The market mechanism highlights that they were not able to achieve more common ground and engage in an activity that fosters the degree of dialogue. Familiarity with one's own expertise and ways to constitute research shows that assumptions within modules persist and can only be altered with small steps. One of these small steps is the aforementioned collaboration between chemistry and biology.

Conclusion

Both the interviewees from the Sava RB sampling campaign and the module leaders emphasized they know some of the partners from previous collaborations. Since Globaqua has many different other partners whom are all responsible for parts of the research conducted the group composition is novel. Previous collaborations do shape some parts of the collaboration, such as the extensive research for the Sava RB sampling campaign. Interviewees from the Sava RB sampling campaign mentioned they weren't familiar with all the laboratories involved. This means one of the structural factors, group composition, in the current endeavour was novel for the researchers participating in Globaqua.

The level of dialogue differs when examined from a small scale and a general perspective. The sampling protocol used as a guidepost for the sampling campaign is two-sided in this aspect. First, it serves as a guidepost to exchange know-how and provide guidelines on how to sample, how to transport these samples and what substances and organisms one looks for. Second, designing the sampling protocol required very discipline-specific knowledge, as

demarcating by discipline alters the required interaction. The protocol serves as some sort of a checklist and could hamper the process of unencumbered exchange and designs show variety to meet the needs presented by different disciplines. Processes of IDR could be slowed down due to the stringent nature of the document. When examined from a general perspective the market mechanism was intended to produce an environment which allows for the creation of shared meaning. However, the added value was not clear-cut in advance of this mechanism, which reduced the chances of adoption. Module leaders speculate that differences in what collaboration to achieve and the lack of added value were the downfall of this market mechanism. Individualism persists between modules which resulted in connection within one's own module and less cross-module collaboration, as managing the integration of insights wasn't actively pursued during the project. Other meetings show much variation in the measures to increase collaboration, which resulted in pluriform attempts to foster integration. The latter could point towards a lack of managerial monitoring: no one felt responsible to overcome boundaries between work packages.

8.5. Exploring the influence of time, language and commitment

Processes of collaboration are shaped by the starting conditions of time, language and commitment. These three factors are essential to reach shared understanding and research synergy in Globaqua. However, when time, language and commitment are present in a positive manner they can improve the overall project and therefore it is important to map their influence on Globaqua. Language, time and commitment are assessed via multiple sources: open ended questionnaire data is complemented with findings from the Sava RB sampling campaign and findings acquired via the interviews with the module leaders. The impeding factors are displayed in twofold. First, quotes from the open-ended questions are presented to provide an image commonly mentioned impeding factors. Second, these quotes are supplemented with interview data from the Sava RB sampling campaign and with findings from the module leaders.

A major impeding factor in combining and integrating knowledge is the time factor. One of the respondents from the 4th GA summarizes the impeding factor time and synthesis as follows:

The main challenge is lack of time, for synthesis, complex work, more / longer projects are needed, generally.

The sampling protocol served as the backbone of the sampling campaign and is often referred to as a plan that has to be finished, and due to its clarity and predetermined character, shaping the conditions for a productive collaboration. Respondents in both the interviews and the quantitative survey note that they are satisfied with the number and quality of collected samples. Researchers agree that much time was invested in developing the sampling protocol and that synthesis and fruitful modelling with multiple disciplines would require additional time and effort. One of the respondents from the Sava RB sampling campaign explicated that the respondent would like to invest into cooperative modelling between hydrology and biology. Due to the required resources and lack of time the respondent concluded that it would be hard to realise via Globaqua:

Because actually we did what was asked, what was planned for the project. But our ambitions are higher. We realised that this was not possible with the current time available and resources. You need more people to deal with the new, and technical issues in models. Actually in biology the models are very simplified compared to hydrological modelling because it's the nature of the study. The basic study for hydrology you have to have applied models which are used for different kind of prepositions and this natural output for some kind of activity in biology we are using statistics to interpret our data but it is different, which different times, we had to focus our joint objectives on the work first to understand what should be the output of the model and then to deal step by step going. This was by my opinion the basic obstacle; this four or five years was not enough to get some kind of extensive process. Such kind of projects should be done.

The abovementioned quote shows that additional time would be required to achieve synthesis between joint objectives. It is apparent that collaborating in an interdisciplinary manner requires more time than doing what one is familiar with. Not all respondents agree on the way the sampling protocols were designed, one of the participants in the Adige mentions the lack of time to discuss different viewpoints: *There's no time to discuss on different research perspectives in the field, and these differences should not affect the sampling. Much of an*

effort was to be put in developing a decent (sampling) protocol because organizing the logistic issues was time consuming.

Another impeding factor in IDR is that of compromising on IDR, which can hamper discipline specific contributions. As module leader 1 summarizes a detrimental factor when committing to IDR: *So the dilemma as we are as a research project that is interdisciplinary research project that some of the compromises that we have to make to really work together reduces the level of interest of research in your own discipline.*

Compromising on IDR means a different research design, mixing methods and being less familiar with the produced results. The latter can be seen when publishing the results; discipline-specific journals often do not accept these contributions, which in turn leads to more insecurity when it comes to publishing the results. EU projects such as Globaqua tend to attract scientists with experience in these kind of projects and some of the participants have experienced multiple projects.

Language is one of the most commonly noted problems within Globaqua. Especially the discipline specific jargon. A gap between participants (technical) background and accompanying vocabulary persists. Acquiring a sense of why and what vocabulary is used takes time. As one of the respondents from the 1st GA puts it:

Lack of common background. Different 'languages' used by different disciplines (mainly between natural and social sciences).

The abovementioned quote marks the differences between natural- and social sciences. Heterogeneity of disciplines can cause differences in framing and over what comprises the problem. Different meanings of the same or a similar concept can be present. Respondents noted that a concept isn't always used in a unilateral way, the meaning and usage varies among disciplines. Comprehending one another's frame takes time and requires researchers to explicate, not being too implicit. The latter is summarized by another respondent from the 1st GA as it is essentially about transferring information and knowledge to another scholar:

Sharing the information and knowledge without spending a lot of time. Difficult in explaining and understanding very specific concepts.

At the start of the project novel concepts, dispersed by other disciplines, emerged. This professional language throughout the project wasn't aligned and understood from the start on. However, researchers found a way to resolve this. Either by using the English words for concepts and partly getting used to unfamiliar (Latin) abbreviations. As one of the 2nd GA participants note:

The main and the most important thing is how to connect stressors and biology. How they affect other spheres of the ecosystem, and what are outcomes. Main challenge is how to improve better understanding of different disciplines because sometimes the language (professional) can be different.

During the interviews with scientists from the Sava RB sampling camping it appeared that language is twofold; both language used across disciplines and native languages used to communicate were mentioned. The disciplinary language impedes the collaboration at the start of the project according to the respondents. They stated it was often hard to comprehend the abbreviations used by disciplines and the Latin that is widespread in some disciplines. It consumed extra time to get to know what terms mean and which are essential and others that are less important. Interviewees agreed that much of the used language was also explained in the sampling protocol, especially the specific and commonly used abbreviations or Latin

jargon. In addition to disciplinary language, the turbulent history of the former Yugoslavia was also mentioned by one of the chemists from the Sava RB sampling campaign:

That is different yes, different generations. I am from the generation that we were all living in the same country; so in Slovenia we had in one year in the primary school the Serbo-Croatian language; because there are not so much different languages. Yea it is definitely because now our kids that are coming from Slovenia they have problems with understanding. But in like 5 days they were able to understand each other.

Researchers participating in the sampling campaign noted that the sampling protocol helped to resolve issues of language and served as a guidepost to select and combine disciplinary insights. Weaving together disciplinary insights requires a breakdown of constructs and assumptions in an reflexive process (Trussell et al. 2017). Increased commitment is required to participate in unfamiliar endeavours and active engagement in the process should be pursued. Respondents from the survey mention that the connection between lower and higher work packages isn't strong. As one of the respondents from the 2nd GA notes the absence of an overall strategy to foster increased collaboration between work packages: *Everyone is willing to work interdisciplinary. However, there is no overall strategy now to do this. The links between WPs are not discussed in detail. This level of concreteness and an overall strategy are, in my point of view, crucial for the success of Globaqua.*

The lack of connection is mentioned frequently, as is the absence of an overarching strategy for cross-disciplinary cooperation. One of the possible explanations why the sampling campaigns were scored as more successful in integrating different insights is summarized by an respondent from the Adige 1st sampling campaign: *working in the field helped for a better understanding of the future data analyses and modelling work. Also exchanging concepts and ideas with people of different disciplines is very positive for the collaboration between the different groups.*

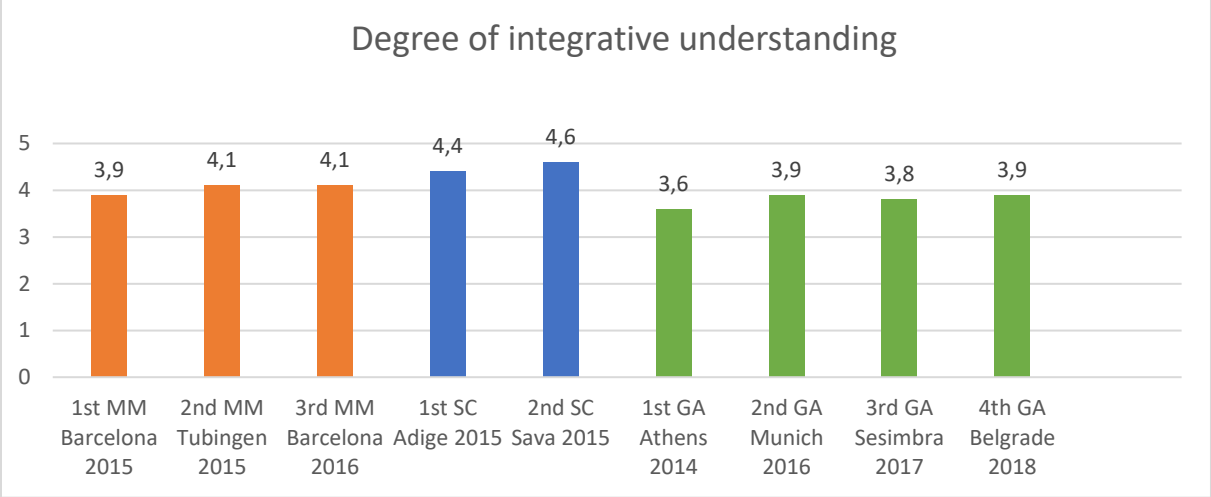
Several factors that influence the overall collaboration are present in Globaqua which are time, language and commitment. The lack of time is mentioned as an impeding factor, profound collaboration requires time to get to know the predispositions of other disciplines. Much time was spend on developing the sampling protocol, leaving less room for more cross-disciplinary approaches and is detrimental to the level of knowledge integration and dialogue. The time factor is at an intermediate level, due to the time pressure the focus relied on getting the sampling protocol ready and less attention was paid to incorporating social time which hampers the development of a fruitful dialogue.
Language is noted as an obstacle: concepts aren't used in a unilateral manner and require elaboration when used cross-disciplinary. Scholars require additional explanation over why and how they use certain concepts. Further discussion and explication of research perspectives is guided or hampered by the project design. The latter explicates to what extent and what goals should be achieved, further integration of data, methods and problem formulation requires additional commitment on top of the delivered project work. Language hampers Globaqua due to the misunderstanding caused by ambiguous language and the extensive time required to get to know each other's jargon and is in between a low level and an intermediate level. Getting to know one another requires understanding one another which was hampered in Globaqua due to misunderstanding the used language and the time effort it takes to acquire a general, project-wide understood, level of language. The latter effects knowledge integration and dialogue, hampering them and leading to a lower degree of both variables.
Commitment to the project and willingness to cooperate is present at an intermediate level, heightened willingness to get to know unfamiliar research practices. The current framework leaves less room for novel cross-disciplinary approaches. However, researchers agreed that

connecting fundamentally different disciplines proves challenging. Especially due to the lack of an overall strategy to combine different fields of research was mentioned, and therefore a higher degree of commitment was not achieved. Knowledge integration was hampered by the lack of an overall strategy, as knowledge integration requires planning and constant communication about how to connect different predispositions.

8.6. Integrative understanding – focus on natural sciences

Integrative understanding is going beyond the sum of its parts, integrating data, methods tools and theories to achieve IDR. The essence is to align disciplinary insights, synchronize between actors and developing a common meaning to coordinate results. Some mono-disciplinary findings are present in Globaqua, as well as multidisciplinary research synthesis (Klein, 2013, Huutoniemi et al. 2010). Integrative understanding will be explicated in threefold. First, the overall findings of integrative understanding throughout Globaqua provide an overarching view via questionnaire data. Second, interview data from the Sava case study is displayed to elaborate on the high scoring of integrative understanding. Third, findings from the module leaders to acquire sense of the global scale of integrative understanding. The core question is if participants were able to go beyond the sum of the parts and align disciplinary insights between individuals who emphasize varying interests.

When examining the overall results from a degree of integrative understanding a high mean is displayed: almost all meetings score around a 4,0 except for the 1st GA at the start of Globaqua. See graph 2 for the means of integrative understanding corresponding with each individual meeting. Module meetings are scored in a similar matter within the three corresponding questionnaires; the mean increased with about 0,3 points and remained at that level the next year. The image for the general assembly's is similar to the module meetings: a slight increase occurred which remained stable over 2016-2018. The category of integrative understanding, consisting of the aforementioned questions, shows that integrative understanding was scored high in both the sampling campaigns: 4,4 and 4,6.



Graph 2, as composed by the author. The mean of integrative understanding throughout Globaqua meetings.

Findings from the Sava RB sampling campaign

Further elaboration on why the degree of integrative understanding scores high will be provided by interview data from the Sava RB sampling campaign. Some aspects of integrative understanding, active integration across scientific disciplines, occurred within the case study of the Sava RB sampling campaign. Most cross-disciplinary collaborations within Globaqua are predominantly among natural sciences. What occurred is cumulation of data, methods and tools. Research within the Sava RB relies on an additive approach. Connection between the

chemical particles and the biota, which is the flora and fauna of a specific region, was pursued. As respondent 1, researcher in chemistry, characterizes the collaboration:

It was good to have them on the terrain because they know more about these biological aspects of the river. They know more about the terrain, where more animals can be found and in which kind of biota. So this were all things that I learned from them. While I knew more of the chemical side. So it was like an interaction from them where the pollutants come from so they could understand why the biota is behaving as it is.

Throughout the Sava RB sampling campaign a clear demarcation between disciplines can be observed: chemists and biologists are responsible for their own research questions and methodological tools. The contributing disciplines remain within their own fields of research and face difficulties when integrating insights. However, some aspects of IDR are present within the Sava RB sampling campaign. Throughout the sampling campaign they collected data together. Collected samples consist of water, fish, mussels and sediment. Gathering the samples does face demarcation by discipline: biologists were responsible for the gathering of fish and mussels and chemists for the collection of water and sediments. The framework, methods, and used tools were determined prior to the sampling campaign in the sampling protocol. The sampling protocol provides instructions for sample identification, handling, preservation and transport. Overarching is the sampling protocol that combines how to study certain samples and provides guideposts to standardize these procedures. Interviewees from the Sava RB sampling campaign state that each contributing discipline was responsible for their own part and it is hard to assess whether an unfamiliar discipline uses the right methods or tools to acquire and analyse the samples. Interviewees from the Sava RB sampling campaign state that integrative understanding is valued because of the merge between natural sciences. In other words, major parts of the activities are conducted along the guideposts of disciplinary boundaries. The collaboration within the Sava RB sampling campaign shows traits of a multidisciplinary approach, as the disciplinary methods were not integrated extensively. Rather than integrative, methods were complementary to one another. Both biology and chemistry have common ground, and an additive or merge between the former can be witnessed. Some knowledge is shared and merged between biology and chemistry. As respondent 1, researcher in chemistry, frames it:

Yes close enough as a science, we are working in a department of environmental sciences so we were chemists but still we were dealing with the environment and dealing with the cycling of elements in the environment. So some general knowledge is present… This biological - biota information about how and where the fish live, the foodweb and how they behave. So I could implement this in my environmental studies. So a good merge afterwards: information about pollution of the river with the life in it.

Findings from module leaders

When examined from a more general perspective it seems that achieving integrative understanding faced several problems, especially developing and discussing shared language. The latter caused confounding of definitions among participants and alter the creation of a shared picture of an empirical phenomenon. Additional time was required to overcome the confounding of used definitions. As module leader 3 states:

But we had several occurrences where it took us quite some time to understand each other in terms of what does this expression actually means in your discipline. So the issue of scale is the best example; spatial distribution can mean something completely different. Scenario can even mean something completely different... But the problems really start when you have common terms that mean different things. Because you use them in your language and everyone thinks that everybody understand, but actually we don't. We understand, but we just understand different things.

Understanding discipline specific issues was stated as being easier than understanding common terms that mean different things. Aligning disciplinary insights was especially difficult when it comes to sharing language. The latter does not imply native languages, but discipline specific often theoretical concepts. One of the module leaders notes it took several meetings to get comfortable with the used concepts and what they define, and therefore synchronisation between participants took additional time. One of the module leaders also emphasized it could be hard within one's own module to align insights. Differences on what theoretical vantage point to adopt were at stake. A rigid approach that followed the project outline and one that was more loosely based on these requirements were being discussed. Eventually they struggled to align these concepts in an integrated way. These concepts were stemming from the same discipline and discussion on theoretical rigidity persisted, even within the same module. Spanning this boundary wasn't solved through active integration, development of a common meaning or synchronization between actors, both concepts were used next to one another.

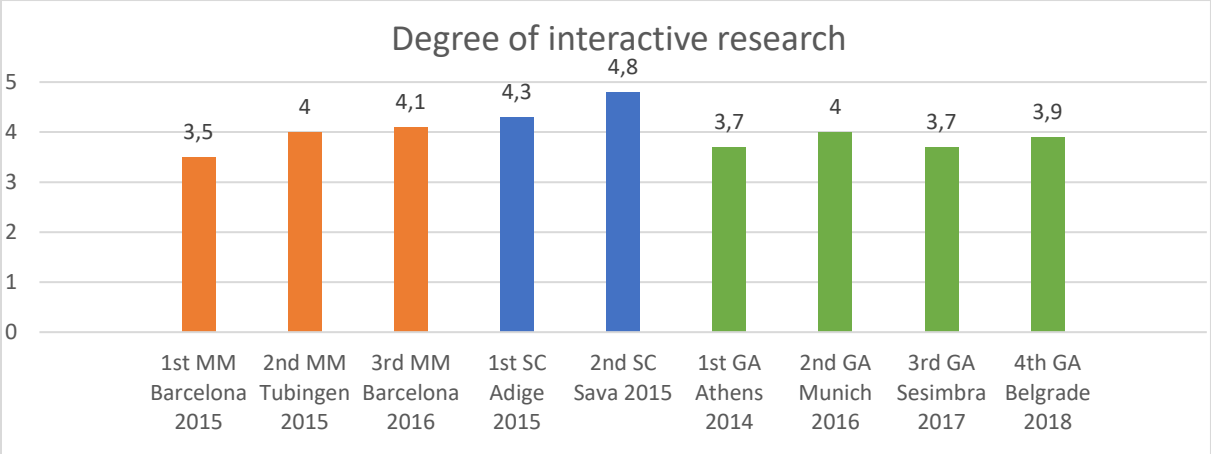
Conclusion

The Sava RB sampling campaign shows aspects of IDR within the domain of the natural sciences. The findings show that these processes are rather additive than integrative and the process is shaped along disciplinary boundaries. Survey results show that integrative understanding is scored high. However, when interviewees from the Sava RB respond on integrative understanding they emphasize knowledge sharing between natural sciences: chemistry and biology. Acquiring and analysing the samples show a clear demarcation in responsibilities, whereby experience in the contributing fields of research is decisive. What occurred in the case study is a unique merge between chemical particles and the biota, albeit guided along the lines of disciplinary boundaries. Due to the merge between natural sciences some of the output generated in the Sava RB sampling campaign is multidisciplinary. Aspects of both mono- and multidisciplinary research can be seen when throughout the Sava RB sampling campaign and results are integrated through a framework. A general perspective acquired via the module leaders shows a different problem: common terms can mean different things and are confounded with one another. Additional time was required to get to know these concepts and coordinate results within their discourse.

8.7. Knowledge integration

Knowledge integration depends on interaction, interdisciplinarity and if researchers feel like they are able to learn from other (disciplinary) findings. The overarching concept is working with a conjoint framework. Knowledge integration will be explicated in fourfold by viewing knowledge integration from a small scale perspective and via a more general perspective. First, a general image will be given by presenting two categories of the aforementioned questionnaire. Interactive research and effectiveness in advancing understanding will be examined. Second, findings gathered through the Sava RB sampling campaign will be elaborated upon to capture how interviewees view knowledge integration. Third, reflection on the integration angle and the process design is explicated through findings administered from module leaders. Fourth, results from the analytical tool developed by the author will be explicated in paragraph 8.7.1.

Knowledge integration relies on the interaction and degree of interdisciplinarity in Globaqua. Both interaction and interdisciplinarity have been captured in the degree of interactive research via the survey. The degree of interactive research has been sampled throughout Globaqua by using a five-point scale. Statements could be answered with strongly disagree, somewhat agree, not sure, somewhat agree and strongly agree, see graph 3 for the means of interactive research corresponding with each individual meeting.

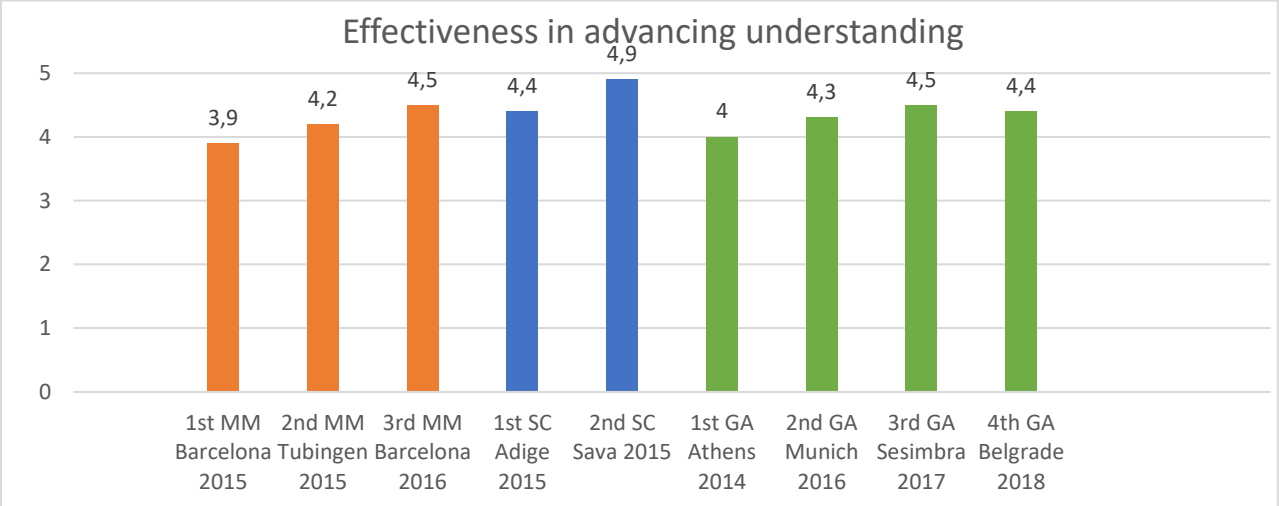


Graph 3, as composed by the author. The mean of interactive research throughout Globaqua meetings.

The degree of interactive research consists of four statements regarding interaction, understanding, integration of research methods and integration of theories and models from different disciplines. The module meetings show quite a large increase, of almost 0,5 points from the 1st meeting which slightly increased during the 3rd module meeting in 2016. Graph 3 shows that both the sampling campaigns score very high on interactive research mean, respectively 4.3 and 4.8. The general assembly scores tend to fluctuate throughout the years, very close towards a 4.0 as mean score.

Another indicator for knowledge integration is interdisciplinary learning. The survey serves as a guidepost once more and summarizes the latter in the category effectiveness in advancing understanding. Effectiveness in advancing understanding consists of valuable scientific outcomes for RBM which are impossible without the collaboration, benefits of Globaqua

outweighing the costs, learning from other disciplines, improving the understanding of other disciplines, improving the appreciation of other disciplines and integrative understanding of water issues.



Graph 4, as composed by the author. The mean of effectiveness in advancing understanding throughout Globaqua meetings.

Graph 4 shows a gradual increase in the module meetings, from 3.9 in Barcelona 2015 to 4.4 in the 3rd module meeting in Barcelona 2016. The sampling campaigns score high, although the difference for the Adige sampling campaign is less substantial compared to the other meetings and corresponding scores of degree of integrative understanding and the degree of interactive research. The general assembly's show a slight increase over the years, and a small decline in the period 2017-2018.

Findings from the Sava RB sampling campaign

When taking a closer look at the findings from the Sava RB sampling campaign these correspond with the high scores depicted in graph 3 and 4. Interviewees mentioned the successful collaboration they've had with their partners, especially via the sampling protocol which provided guideposts prior to the sampling campaign. During the interviews with respondents from the Sava RB sampling campaign they've emphasized their level of satisfaction with the acquired results during the sampling campaign and the possibility for extended use of the data. As respondent 2 notes:

Preparing publications mostly and finishing some kind of data processing. There is still many possibility to deal with the data. By my opinion we are able to fulfill all that was asked from us. But since the data that was collected by the project was quite huge. But we also collected the data from other sources. This is a very good base for the continuation of the project work. Establish some kind of platform that will ensure that the data will somehow live.

The abovementioned quote illustrates why interviewees from the sampling campaign are happy with the gathered results and helps to know why all categories in the questionnaire are valued as very good, being in the range of 4.0 to 5.0.

Findings from module leaders

Seen from a more general perspective through the findings of module leaders the experiences are more reflective. Findings from module leaders show a lower degree of knowledge integration due to a required basic understanding of the matter and aligning interests. Seeing the perceived added value of cooperating with other modules and a lack of active steering on knowledge integration during the project were mentioned as impeding factors. Integrating unfamiliar insights requires a basic understanding of how work done by others can contribute to a better paper or more profound research. Knowledge about what others do has to be present at the start of the project. As module leader 1 notes:

Well it is always interesting, and again, you need somebody to explain when and see where the integration angle is. I don't feel uncomfortable unless I do not understand the very basics. If the researcher leading the work can explain it and can explain the way that is relevant for your work. I don't need to know all the details of chemical analysis, I will never use them. I need to know why it is relevant to my work and how it can be integrated…So it is quite important to identify who the group of people are with whom you really have to integrate from day 1.

The abovementioned quote shows that researchers struggle to see how other people's work is relevant for them and how it could be used in a conjoint way. Acquiring a sense of the integration angle and why the work is relevant for one another needs to be actively managed. In addition to the integration angle, knowledge integration is prone to differences in scale, usually demarcated by discipline or method. Multiple module leaders stressed that the scales on which they operate might impede increased knowledge integration, as founding common ground in order to compose a conjoint framework, collect and analyze data together gets more difficult. Especially the differences between natural- and social sciences were emphasized regarding the differences in scale. As module leaders 2 and 4 emphasize that integration of knowledge requires active aligning of interests for implementation to succeed:

We go to the field, we take samples and we have results specifically for the site. I think that the work packages related to implications, especially for implications are more working with models. With the highest scale; they need for example not 6 or 7 10 data about one basin, they need hundreds of data about several basins (module leader 2).

Because we are working in a different level or you need different things which I cannot get for you. That is my feeling, that we have not linked very well the most experimental modules with the most socio-economical models (module leader 2).

Just communication or collaboration is not enough, for integration to succeed it has to be designed. You cannot just expect to leave people alone, then come together and integrate. You have to integrate from the start so what they do is designed to be integrated. I thought this was in the research proposal, but in the implementation this did not happen (module leader 4).

Conclusion

The questionnaire results depict a project overview that has scored high, both via the degree of interactive research and effectiveness in advancing understanding. In retrospect, findings from the questionnaire show that a high degree of knowledge integration was achieved and that the collaboration within Globaqua is very successful at integrating findings and learning

from one another. The interviews show a more nuanced finding and remarks on Globaqua were discussed.
The abovementioned quotes from the interviews with the module leaders show is a lack of implementation via a form of management. Actively aligning, or linking, of interests and research was not steered in an active manner during Globaqua. The project design was written in an interdisciplinary manner, but a vacuum of steering occurred when pursuing the designated goals. Module leaders stressed that they felt a lack of an undergirding mechanism and legislative body to actively monitor knowledge integration. No one felt responsible for the interdisciplinary process in the current unregulated process when it comes to managing integration: steering the integrative process requires additional warranties imbedded in the project design. In other words, regulation of the process didn't happen as a spontaneous process and should be administered by a legislative body enforced through project design.
When putting the pieces together it is apparent that the data is acquired in different levels and a layered image of Globaqua persists, one that is very positive and one that shows a more reflective approach on Globaqua. Evaluating knowledge integration shows that questionnaires leave little room for thorough reflection on the given scores, open ended questions were answered in a brief manner. Interviews helped to complement the gap: the need for constructive criticism and reflection on the project are fulfilled. By viewing both the questionnaires and the interviews a layered image is shown: knowledge integration is valued as being successful throughout Globaqua and remarks are made about what could be improved.

8.7.1 Results from the analytical tool

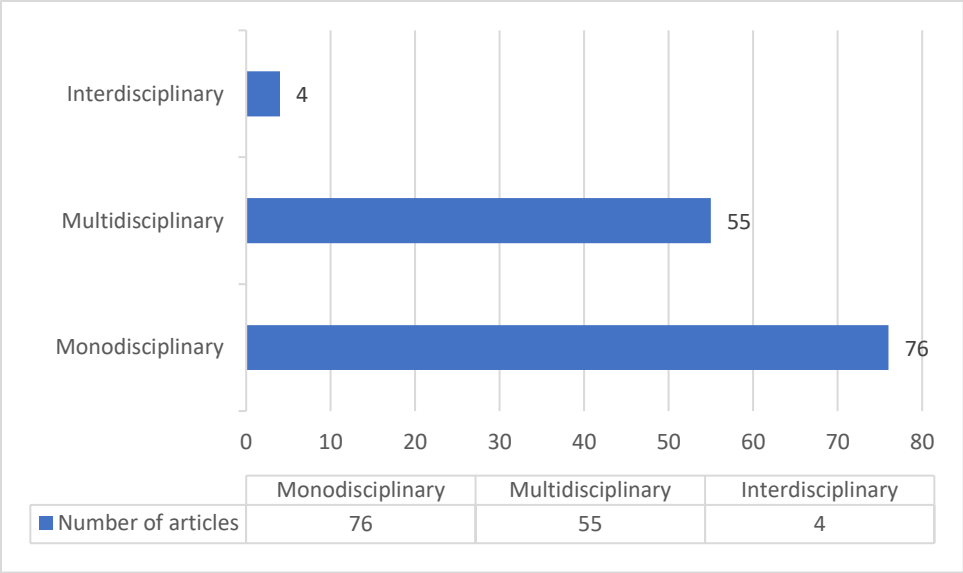
Throughout paragraph 8.7.1 the results from the analytical tool will be presented in twofold. First, a general overview of the assessed articles arranged by module accompanied with their N and the percentage each module represents within the 134 articles that were examined. Second, the scores generated via the analytical tool will be presented in two bar charts. The categories formulated to assess the level of knowledge integration will be briefly elaborated upon. Third, why articles score in a certain category will be explicated, examining what aspects fit the disciplinary demarcation.

Table 8 shows that the centre of Globaqua output is focussed on module 1 and module 2. The score is composed by assessing each article individually and based on the description of the module assessing whether it fit or not. The latter was derived from the model used by Navarro-Ortega et al. (2014), which is depicted in the case introduction as figure 1. Ranging from doing fieldwork to management practices: Stressors from module 1, receptors module 2, implications module 3, environmental management module 4 and coordination and dissemination of management practices in module 5. Together module and module 2 comprise a total of 90% of the articles, and therefore the centre of the output consists of module 1 and module 2. Module 3, 4 and 5 make up for the other 10% and are underrepresented when it comes to quantity of the generated output.

Module	**N**	**Percentage**
Module 1 stressors	N = 69	52%
Module 2 receptors	N = 51	38%
Module 3 implications	N = 4	3%
Module 4 environmental management	N = 7	5%
Module 5 project coordination and dissemination	N = 3	2%
Total	***N = 134***	***100%***

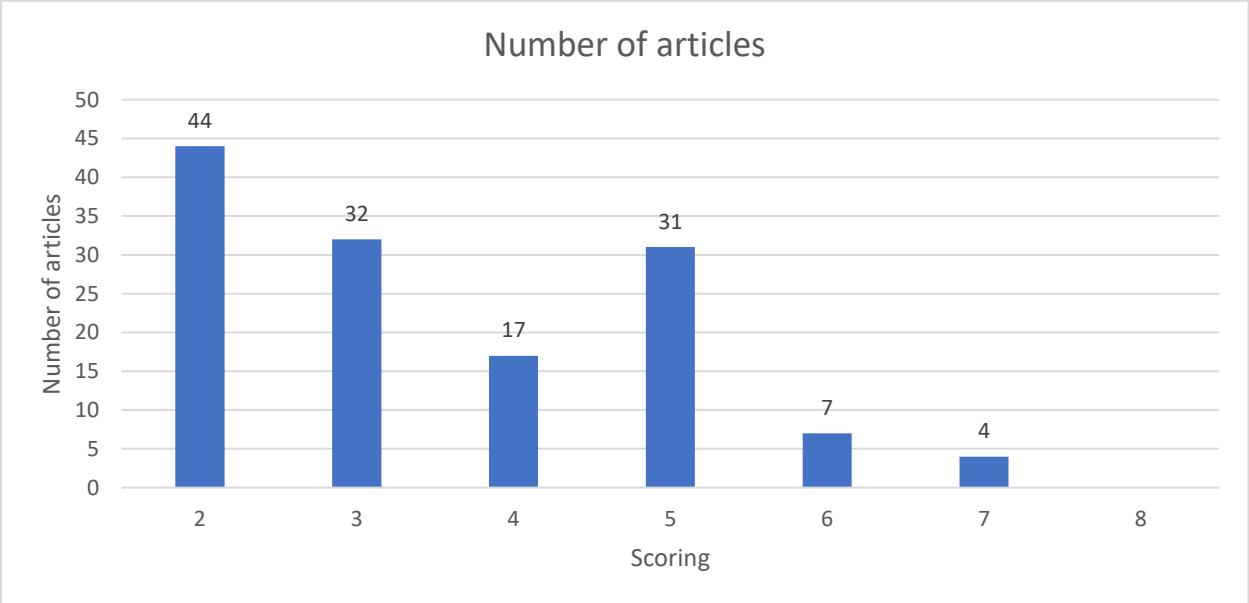
Table 8, an overview of the scored articles arranged by their module and the percentage of the total they represent.

The abovementioned numbers on knowledge integration are lop-sided, due to the high number of articles in the first two modules it shows that output produced in Globaqua is largely focussed on natural sciences. Table 5 is composed by the author and colleagues from TNO by comparing the content of modules with the content of the article. The abovementioned table cannot help to illustrate to what extent integration has occurred. To fill this gap the examined articles will be shown presenting the accredited score per individual article. All the articles have been scored twice by different scorers and these scores have been corrected to show one score per article.
The below mentioned graph shows the scoring of the analytical tool. The frequency is displayed on the Y-axis with the number on each bar. The accredited score can be found on the X axis underneath each bar. Why articles are scored in a particular manner will be elaborated further in order to view what traits they possess that cause them to fall in one of the three categories.



Graph 5, as composed by colleagues from TNO displaying the number of articles accredited within each category.

Graph 5 shows that a lot of the output composed by researchers in Globaqua consists of monodisciplinary and multidisciplinary findings based on results stemming from the analytical tool. Interdisciplinary articles are scarce throughout the project. Scoring from 2-3 points is accredited is a monodisciplinary score, 4, 5 and 6 points are accredited to multidisciplinary articles and 7-8 points are interdisciplinary. Multidisciplinary findings are the largest category due to their ambivalent nature: they possess qualities of both monodisciplinarity and of interdisciplinarity. So far centre of gravity has been depicted when examining the output generated by Globaqua.



Graph 6, the frequency of the accredited scores as composed by colleagues from TNO. On the y axis the number of articles is displayed, on the x axis one can see the accredited scores.

The abovementioned graph shows that a lot of articles are monodisciplinary and accredited with the lowest score of 2 points. Another remarkable score is that none of the articles is

accredited with 8 points. The section below depicts the findings in each category and also displays the scoring range.

Traits of monodisciplinary articles (2-3 pt.)

The monodisciplinary articles possess common traits. Lots of articles strive to increase highly specialized knowledge that is applicable in a designated field of expertise. The result is that the focal point is on increasing knowledge within a single discipline and the acquired knowledge regards stressors and implications. Note that exceptions persist, some articles tend to contribute to other modules to a low degree: remarks about the influence on other fields or studies are briefly mentioned. Quite a lot of articles consist of the examination of a certain particle, which ranges organic to inorganic, and their effects in a variety of ways. What these articles do not possess is bridging the gap towards other disciplines, that is striving for integration outside of their own discipline. Their contribution lies mostly on acquiring more knowledge within their field of expertise and not so much on integrating different insights.

Traits of multidisciplinary articles (4-5-6 pt.)

The multidisciplinary articles possess certain common traits as well, however the watershed isn't always clear. Traits of both monodisciplinary and interdisciplinary studies are present. The emphasis is on findings that revolve around monodisciplinary studies. What makes them distinct from the monodisciplinary articles is there is more attention for the systemic side, management practices focussed on a single river are incorporated. Implications for management stem from these cases. Strategies or recommendations for the future are not that thoroughly explicated. Hints towards possible strategies are presented, but the emphasis of the articles usually revolves around explaining the cycling of a certain stressor in the environment. When nearing the score towards interdisciplinary findings, consisting of 6 points, one can see articles that describe past and present projects as well as the function of some institutes. By concept these articles show interdisciplinarity and show they are trying to actively pursue interdisciplinarity. In practice some of these articles lack the connection to empirical aspect. Once more, it can be hard to distinguish the multidisciplinary articles from their adjacent categories: aspects of both categories are present.

Traits of interdisciplinary articles (7-8 pt.)

The four interdisciplinary articles examined via the tool possess distinct common traits, which are less present or even absent in monodisciplinary and multidisciplinary articles. Two traits stand out. First, an active integration of frameworks which incorporate a variety of disciplines and actors. Scholars that contributed to these articles have very different backgrounds and expertise. Second, the articles use empirical findings found at the stressors and implications level to compose recommendations for management. By doing so there is an integration of disciplines, both- natural and sciences are incorporated and the findings in the former are incorporated in the latter. These articles aren't multidisciplinary due to the active integration of empirical data into management practices. Some multidisciplinary articles also hint towards interdisciplinary, however they employ a theoretical vantage point. The wish to incorporate findings is presented and the step towards integration wasn't fulfilled yet as active synthesis of empirical and conceptual components wasn't reached. Articles that are valued as interdisciplinary incorporate the connection between empirical findings and recommendations for management.

Conclusion

Throughout section 8.7.1. the results from the analytical tool are dispersed. It is shown that the majority of articles is valued as being mono- and multidisciplinary and 90% of the articles were contributed by module 1 and module 2. Only four articles fall in the category of interdisciplinarity. However, searching for distinct traits per category shows differences. First, monodisciplinary articles revolve around expert knowledge that contributes to acquiring more knowledge within a specific field of expertise. The latter often occurs around the cycling of an organic- or inorganic particle within a specific environment. Second, multidisciplinary articles show a less clear image: they incorporate aspects of mono- and interdisciplinarity. Multiple disciplines are involved and usually one strives for synergy between various contributions. However, the synergy is often of conceptual nature. Project descriptions as well as articles regarding specific institutions are clear examples. Both strive for active synergy from a theoretical vantage point.
Third, interdisciplinary articles are scarce and strive for active integration of frameworks and use empirical findings regarding particles to compose management practices. A combination between natural- and social sciences occurs.

8.7.2. Recapturing knowledge integration

Section 8.7.2. will provide a recap on knowledge integration where the insights from the different data sources are combined to provide an overview of knowledge integration in Globaqua. By doing so the results from the multimethod approach can be applied which helps to provide a nuanced understanding of knowledge integration in Globaqua.

Findings from the questionnaire show that a high degree of knowledge integration was achieved and that the collaboration within Globaqua is very successful at integrating findings and learning from one another. Via the questionnaires researchers show they are very successful when it comes to integrating finding and aligning ideas within Globaqua. The other sources help to provide a more nuanced overview of the project. Module leaders emphasized during interviews they felt the lack of actively steering, managing of, on the goals formulated in the project plan. The need for active regulation was emphasized by the module leaders. Findings from the Sava RB sampling campaign show they were successful at preparing publications, processing data and the extended use of data together. The overall collaboration and active integration within the sampling campaigns were emphasized. Due to the extensive research and living together for a short period of time were success factors of the Sava RB sampling campaign. When examining findings from the analytical tool once more it is shown that the majority of published articles was contributed by module 1 and module 2 and very much articles were valued as being either monodisciplinary or multidisciplinary. Findings from the analytical tool show that quite a lot of the produced output is monodisciplinary, and some articles show integration of ideas and actively involve multiple disciplines.

When taking into account all these sources a layered image appears, one in which small steps towards integration are taken. However, room for improvement is frequently mentioned by module leaders in future EU projects to establish more knowledge integration among the project participants. Exemplary for such a large project is that some parts succeeded better at integration than others and a uniform criterion would do no justice to Globaqua. Via the analytical tool it is shown that truly achieving integration when it comes to output is hard to establish and integrating insight goes step by step. Some conceptual articles do show high levels of knowledge integration. Further knowledge integration exceeds the lifespan of a single project and can possibly be seen when reflecting on multiple EU projects over a larger period.

8.8. Recapturing the model – linking the pieces

Throughout this section a recap on the conceptual model will be provided. Elaboration on how the differences in knowledge integration can be understood based on the framework will be explicated. It is important to take note of the individual differences that persist throughout Globaqua, some researchers engaged in novel ways of cooperation to integrate ideas, knowledge and insights from various disciplines. Other researchers contributed in a more conservative way to the project, conducting research in ways they were familiar with. Linking the pieces will be done by using the conceptual model from left to right: starting with atmosphere and open-mindedness and finishing with knowledge integration. The concluding part of section 8.8 will provide an explicit explanation of how the variables influenced each other.

It is shown that atmosphere and open mindedness are present throughout Globaqua. Via the questionnaire respondents report high scores on atmosphere and the willingness to listen to one another and feeling comfortable within the group as well. The interviews constitute this image and respondents emphasize thee willingness to participate in interdisciplinary science and the importance of learning from one another. The starting conditions directly affect dialogue and trust, as respondents state they are comfortable regarding the group atmosphere and willing to learn and listen in relationship with one another, they are open minded when it comes to engaging in novel research synergies.

The degree of dialogue differs in Globaqua per individual case, especially when viewed from a small scale and a general perspective. It is shown that respondents know some of the project partners from previous research and that a demarcation can be drawn between within module(s) and cross-module cooperation which leads to a different degree of dialogue that is attained. The aforementioned sampling protocol helped participants to combine different fields of research and serves as an example of a best practice. The protocol served as the backbone of the field research and was constituted through intensive contact on what to in- and exclude. When examining dialogue on a more global level it seems that combining insights into an overarching scheme suffered some resistance. The market mechanism is used as an example of an integrated framework and has been used as a component to assess the degree of dialogue. Respondents were reluctant about the added value of the market mechanism as it is hard to assess whether it will be useful from the start on and in what way it would work. In other words, synthesizing knowledge and crossing boundaries shows differences which lead to a different degree of dialogue that is attained. The degree of dialogue is linked to integrative understanding, points of view and dispersing information was not equal across Globaqua. Connectedness to one another, both in terms of resources as for specialized knowledge shows differences. The different degree of dialogue leads to a differing degree of integrative understanding. The differences in dialogue lead to a different degree of working together with varying disciplinary insights and differences in synchronization between actors. In other words, the level of dialogue directly affects the degree of integrative understanding that is attained, and these levels are different per case in Globaqua.

The degree of trust differs in Globaqua per individual case, especially when viewed from a small scale and a general perspective. Keep in mind that each relationship in the project could serve a different need. In other words, not every relationship requires the same amount of

attention and development, and therefore differences in the degree of trust are shown. Examined relationships in the project are currently at knowledge-based-trust and remain at the level of a working relationship. It is vital to note the influence of informal interaction as it really helped to acquire more knowledge about each other, about the research and about unfamiliar disciplines. The Sava RB sampling campaign is the core example of informal interaction. Other modules, less engaged with the sampling campaign, show they rely more in formal interaction and weren't able to spend an extended period of time together outside of the official project meetings. Modules that didn't engage in the sampling campaign had more difficulties to represent needs of other's and make compromises that benefit the overall research.
Reflecting on the demarcation by module it seems these values were less actively pursued than mentioned. Committing or consenting to the status quo was the outcome, as further integration between modules wasn't actively fostered. The latter results in the level of integrative understanding that evolves within modules and less evolvement cross-module. The latter can be seen in the Sava RB sampling campaign where small steps in integration between natural sciences are achieved. A combination between chemistry and biology is pursued: chemical pollutants and their role in the biota were seen in a more systemic manner. The latter can be seen as both assessing the degree of chemical pollutants and having a better idea of where these come from and how they spread throughout the ecosystem. Seen from a global level integrative understanding portrays a different picture: the same concepts were not always understood in a similar manner and overcoming the issue of different definitions consumed some time. This brings us to the major factors that influence knowledge integration: time, language and commitment. When assessing time it seems that project demands were met, however further integration of research would require more time than the 5 years the project ran. Language shows different issues; that of communicating in native languages and that sharing information about very explicit topics requires profound understanding of the subject. Concepts aren't used in a unilateral manner and can require further elaboration when used cross-module or in a cross-disciplinary way. Assessing commitment it shows that ties between work packages are loosely connected. Due to the lack of an overall enforced strategy the absence of an overall managerial work package or module is felt. The Sava RB sampling campaign was able to, albeit partially, overcome the lack of an enforced strategy by providing a sampling protocol. The protocol served as the backbone for their field research and was strictly managed by the corresponding work package- and module leaders.

Concluding the recap each concept presented throughout the conceptual model will be reflected upon. The purpose of this conclusion is explicit explanation of how the variables influenced each other.
Atmosphere and open-mindedness directly influenced dialogue and trust as starting conditions through feeling comfortable in the group and willingness to learn from one another to engage in novel research synergies. Dialogue was influenced by time, language and commitment. These three factors influenced the collaboration through the mechanism of providing starting conditions. The level of dialogue was influenced by time via connecting disciplines with one another. Respondents stated they were able to fulfil project demands within the timespan of Globaqua. However, truly achieving integration, sharing information and knowledge, requires to spend more time together. In other words, to achieve integration more time needs to be spend on dialogue. Language is an important part of dialogue, as it is used to understand one

another. A frequently mentioned problem in Globaqua are different definitions of the same variable which cause confusion among the participants. In other words, confounding different meanings of the same variable with one another. Confounding different meanings of the same variable influences the degree of dialogue as it is a prerequisite to get to know and understand each other. This leads to a lower degree of dialogue because it is harder to evolve as a group as one has a different understanding of the used variable. Commitment to get to know one another and the effort that is required to achieve integration are present throughout Globaqua. Respondents are aware of the additional commitment that is required and state they have the willingness to invest in Globaqua. Commitment is present which has a positive influence on the degree of dialogue: respondents are willing to invest in getting to know unfamiliar practices and learn from one another to achieve integration.

Dialogue influenced integrative understanding through the mechanism of different content and organisation per individual case as modules produced their own ways to conduct research and with whom. In other words, the lack of management on integration caused fragmentation and lead to different styles of module management to organise research. The degree of trust throughout Globaqua was determined by previous collaborations and the differences in interaction, either predominantly through informal- or formal interaction. The degree of integrative understanding was hampered due to the expert knowledge present in a vast array of disciplines, which can be hard to understand by researchers that are not familiar with the subject.The degree of integrative understanding is directly influenced by trust and dialogue, previous collaborations and knowledge about disciplinary insights are constituting elements. The underlying mechanism is between disciplines that show epistemological resemblance and they were able to integrate findings with one another. The Sava RB sampling campaign is an example of the merge between disciplines: intertwining chemical and biological findings. Once more, differences in the degree of integrative understanding exist within parts of the project. The degree of integrative understanding that was achieved is at an intermediate level, where different concepts from various disciplines are incorporated. The degree of integrative understanding did not achieve a higher degree due to the inability to integrate frameworks and a common language to realise integrative understanding was not achieved. Note that individual differences are persistent throughout the project, not all work packages were able to come to a shared understanding of an empirical phenomenon.

The degree of knowledge integration is directly influenced by time, language and commitment and the degree of integrative understanding. Due to the extra time, understanding each other's language and willingness to commit knowledge integration is influenced. Additional time is required to align research frameworks which also require to understand each other via the used language. Willingness to commit and invest into knowledge integration was present. When looking at the empirical sources differences throughout Globaqua are present for knowledge integration. The sava RB sampling campaign is a primary example of where knowledge integration, albeit in small steps, succeeded. Module leaders emphasized they were unable to successfully align cross-module cooperation. The analytical tool shows differences as well. These differences rely on previous collaborations with one another and seeing the added benefit of incorporating insights from different studies. Respondents noted they struggled to see the value of incorporating studies they were not familiar with. What we see here is that the Sava RB sampling campaign succeeded in integrating knowledge due to spending social time together and the scale on which they operate: incorporating actors that share predispositions when doing research which fostered

integration and made it easier to achieve integrative understanding. As for scale it can be noted researchers in the Sava RB sampling campaign explored cooperations that existed prior to Globaqua mostly between two departments of universities. They understood the language each involved discipline spoke and were committed to the process for more than a decade prior to Globaqua. Due to the prior commitment regarding the Sava RB sampling campaign it shows that integrative understanding shapes the process of knowledge integration. However, not every part of Globaqua was able to achieve such a profound collaboration and differences exist when examining various parts of the projects. The degree of knowledge integration varies between an intermediate and a low level, data is collected together but is often bound to disciplinary demarcation. This demarcation is shown when examining the published articles via the tool: these results are mono- or multidisciplinary by nature.

9. Conclusion and recommendations

In the present study scientific knowledge integration has been examined via the following main question: *What is the degree of scientific knowledge integration reached in Globaqua and what is the role of trust and dialogue in the process of coming to knowledge integration?*

The concluding part of this research consists of two parts. First, answering the sub- and main question on a meta level whereby a more reflective point of view that incorporates the literature will be used. Second, recommendations for future research based on the main conclusions will be presented. The theoretical model used throughout this study focussed on building up relationships and integrating practices via dialogue and trust. The model presupposes that atmosphere and open-mindedness affect dialogue and trust. Dialogue and trust shape integrative understanding: when a higher degree of trust and dialogue are reached it is easier to achieve integrative understanding. Assessing time, language and commitment on integrative understanding is done to grasp some of the most noteworthy factors that influence interdisciplinary research collaboration. Time, language and commitment can alter the overall level of knowledge integration that is achieved.

Starting off with the first sub question: *what is the level of scientific knowledge integration in Globaqua?* Throughout this study it is shown that differences in the level of knowledge integration are present in Globaqua. Due to the large scale and numerous actors involved one all-encompassing answer cannot be provided. The sources show individual differences as well. The questionnaire shows very high overall means, which would imply that scientific knowledge integration is achieved and strived for throughout the entire project. The interviews help to complement this view: knowledge integration is usually achieved within module collaboration, rather than cross-module collaboration. When examining the analytical tool one should consider this sample is inflated by the large sum of articles in module 1 and module 2 which comprise 90% of the articles. Module 3, 4 and 5 make up for the other 10% and are underrepresented when it comes to quantity of the generated output. Knowledge integration was achieved in some parts of the project, especially the merge between biota and chemical stressors in a systemic sense. In other words, knowing more about the cycling of these chemical stressors in the environment, where they come from, and how they influence the entire system. The merge between biota and chemical stressors is different from well-known practices such as getting to know a small part of these elements in detail. Due to the informal interaction that occurred on the research site researchers from the Sava RB sampling campaign were able to learn more about one another and get to know predispositions. This altered scientific knowledge integration. A difference in modules that didn't participate in the sampling campaign exist, they had to rely more on the formal meetings throughout the project and didn't have time on-site to discuss about their research. When reflecting on the literature it seems the demarcation between mono-, multi-, inter-, and transdisciplinary can be a rather big step. Assessing whether an article is mono- or multidisciplinary can be hard: aspects of both can be present making the watershed less clear than presented before. In other words, the level of scientific knowledge integration in Globaqua isn't unilateral and some interdisciplinary aspects are shown via small steps. Especially the collaboration within the domain of the natural sciences shows scientific knowledge integration. These steps are small when considering the range of IDR, the disciplines that integrate knowledge show similarities in dispositions as they remain largely within the domain of the natural sciences. The

aforementioned systemic thinking about biota and cycling of pollutants in the environment is the clearest example.

The second sub question is as follows: *What is the level of trust in Globaqua?*
Aligning frames, insights and integrating ideas requires trust in one another. Various parties depend on each other and based on to what extent they know each other the level of trust occurs. Trust is an incremental process and tends to build on positive feedback that reinforces the initial behaviour once it is assessed as being positive. The level of trust also shows some differences, albeit to a smaller degree than scientific knowledge integration. Note that trust could not be measured with the questionnaire and the analytical tool. Acquiring a sense of trust in Globaqua is done by conducting and analysing interviews. Respondents agreed they knew some actors from previous research collaborations. Since projects tend to differ on their composition researchers do not know everyone and every institution involved. Usually they know the major contributors to the project and some closely related researchers and institutions they have ties with. Trust increases when parties get to know one another better and that is where the major differences persist. Examined relationships in the project are currently at knowledge-based-trust, the level undergirding a fruitful working relationship is achieved. Individual differences might occur, as far as the present research was able to detect these relationships are at the level of knowledge-based-trust. Due to general communication and knowing what other researchers want to contribute most participants are able to acquire a basic understanding of what the other will do and what he or she is striving for. Identification-based-trust requires spending more time with one another and being able to vouch for and substitute for the other. Highly specific fields leave little room to vouch for the other as the surplus of knowledge one possesses is hard to substitute for. In addition to the surplus of knowledge there is also management and steering from the module leaders present on what output should be acquired within a certain module. Surveillance or monitoring impedes the gradual evolvement of knowledge-based-trust into identification-based-trust in the case of Globaqua.

The third sub question is as follows: *To what extent has a constructive dialogue evolved?* The level of dialogue also shows differences throughout Globaqua. Examining the degree of dialogue is done through interviews and assessing observations. The Sava RB sampling campaign shows that the used sampling protocol provides guideposts to exchange know-how. However, the sampling protocol could impede the process of dialogue due to the stringent deadlines, no room for adaptation or a slightly altered point of view is possible. A uniform measure is hard to present. When examining the results from the module leaders it shows that integrating ideas, knowledge and findings was quite hard due to the inward focus of modules on their own output and functioning. Cross-module cooperation didn’t occur as much as specified at the start of the project. The cooperation within modules shows that modules employ their own habits of conducting research. Module leaders emphasized it was much easier to align these interests due to knowing what one needs to align research. Essentially it is about knowing better where and how the connection between research can be made. Cooperation within modules was emphasized by module leaders as being easier due to the scale and scope being smaller: research disciplines were less different from one another and it is easier to connect researchers if their number is smaller. The smaller scale and scope benefits dialogue; getting to know the wants and preferences of researchers is easier to

combine in an approach that fits multiple disciplines. In other words, the level of dialogue increases due to the smaller scale and scope.

The fourth sub question is as follows: *How do time, language and commitment influence dialogue and knowledge integration?* Time, language and commitment are assessed as being either complementary or detrimental to the research. Individual differences per factor are displayed. Knowledge integration in a profound way consumes additional time compared to discipline specific (monodisciplinary) research. This could mean that integrated research findings will be contributed when the project deadline has passed. Integrating disciplines requires additional time to achieve synthesis between joint objectives. In other words, designing research together requires intensive communication and deliberation. Respondents in Globaqua noted there is enough time to conduct the actual research, while coming to integrative understanding takes longer than the runtime of Globaqua. Language is intertwined with time, as concepts need to be understood in a unilateral way which takes time. At the start of the current research it seemed like hard to comprehend abbreviations and discipline specific jargon would be among the issues within Globaqua. However, jargon was declined by the respondents as being problematic and they noted a different problem they faced in terms of language, mistaking the same concept with different meaning. Confounding definitions of a concept was frequently mentioned as being problematic. In other words, researchers thought they spoke of the same concept but the content varied which hampered integrative understanding. The effect on integrative understanding is that it took longer to overcome the confounding of definitions and slowed down the evolvement of integrative understanding. Commitment is shown to be present in Globaqua, however striving for cross-module cooperation has been achieved to a lesser extent and would require additional effort due to the alignment of interests and the novelty of cooperating. Seeing the research problem through a ‘’new lens’’, one that is composed of several (disciplinary) findings wasn’t reached as much. Much of the focal point was aimed at collaboration within one’s own module. The intention to increase collaboration across modules was widely dispersed, however integrating frameworks in practice was seen as time-consuming and requiring lots of effort from various disciplines. In other words, much researchers focussed on what they knew prior to Globaqua and they were committed to conduct more research into these insights which is hampering to the degree of integrative understanding.

To finish first part of the conclusion an answer to the main question will be provided based on the findings from the sub-questions. The main question is as follows: *What is the degree of scientific knowledge integration reached in Globaqua and what is the role of trust and dialogue in the process of coming to knowledge integration?*

The degree of scientific knowledge integration shows differences due to the large scale of the project. Scientific knowledge integration is achieved within modules, less in cross-module cooperation. Atmosphere and open-mindedness directly influenced dialogue and trust as starting conditions through feeling comfortable in the group and willingness to learn from one another to engage in novel research synergies. Dialogue shows differences throughout Globaqua. Individualism exists between modules which resulted in connection within one’s own module and less cross-module collaboration, as managing the integration of insights wasn’t actively pursued during the project. Dialogue influenced integrative understanding through the mechanism of different content and organisation per individual case as modules produced their own ways to conduct research and with whom. Dialogue was influenced by

time, language and commitment. These three factors influenced the collaboration by serving as starting conditions. Time and language influenced the degree of dialogue in an impeding way due to stringent deadlines and understanding the language used project-wide. Different definitions of the same variable caused confusion, especially confounding different meanings of the same variable with one another. A high degree of commitment is present throughout Globaqua and had a positive influence: heightened willingness to get to know unfamiliar research practices. The degree of trust and dialogue throughout Globaqua was determined by previous collaborations and the differences in interaction, either predominantly through informal- or formal interaction. The absence of managerial input to increase integrative understanding is a detrimental factor to the overall degree of collaboration that was achieved. Informal interaction helped to foster integration between disciplines, the Sava RB sampling campaign is an example of the latter. The demarcation between informal- and formal meetings is seen whereas module meetings were emphasized to foster integration, general assemblies suffer from flaws by design and the sampling campaigns blossomed through informal interaction. Especially the lengthy reportive nature of general assemblies caused discomfort among the participants, these were conducted along the lines of formal interaction. Integration during the general assemblies was hampered by the inability to address questions and the tight schedule that was developed for these meetings. Sampling campaigns were once more addressed as fostering integration. Knowing the wants, preferences and dispositions of one another can help to attain more integration and combining informal and formal meetings constitute integration. In other words, informal meetings can foster trust and dialogue among one another which lead to a higher degree of integrative understanding. During the sampling campaigns in the Sava RB researchers spend social time with each other due to the fieldwork that required living in close proximity of each other which increased the degree of trust and the level of dialogue that were attained.
The degree of integrative understanding was hampered due to the inability to transfer expert knowledge onto others, thus making it hard to understand for disciplines that are not familiar with the subject. The degree of integrative understanding is directly influenced by trust and dialogue: previous experiences with collaboration and knowledge about disciplinary insights are constituting elements. Attaining a fruitful dialogue is shown to rely on both formal and informal ways of interacting with one another. Trust is fostered based on previous experiences and clearly stating what one wishes to achieve and acting in accordance with these promises. The underlying mechanism which connects trust and dialogue with integrative understanding is epistemological resemblance, disciplines that show familiar vantage points connect easier throughout Globaqua than others who do not possess epistemological resemblance. In other words, bridging ties with disciplines that are like the one a researcher is familiar with is easier. The Sava RB sampling campaign is a clear example of where ties were bridged easier due to epistemological resemblance: a connection between chemistry and biology was attained. Module leaders emphasized the lack of resemblance they experienced, which led to unclear ideas about the added benefit of incorporating a field they were not familiar with and less cross-module cooperation.

The degree of knowledge integration is directly influenced by time, language and commitment and the degree of integrative understanding. The mechanism underneath is the way the interaction is shaped and guided by the project management. Combining components from different fields was hampered by time and language, commitment didn't prove to be a challenge. Respondents stated that the project plan incorporated a lot of IDR and they stated

five years was not enough to fulfil these goals. What can be witnessed in Globaqua are large differences when it comes to collaborating in order to do interdisciplinary research. There are parts of the project that actively collect and analyse data together and publishing the acquired data in one's own field, which is supported by the findings presented in the analytical tool. Others tend to do research on their own which has no focus on integrating knowledge and is merely intended to improve the knowledge within one's own discipline. The degree of knowledge integration differs between a low and an intermediate level, researchers often do collect and analyse data together but they struggle to combine these efforts in integrated studies. What is lacking is the process of coming to knowledge integration: coming to a shared understanding of the empirical phenomenon. In other words, due to the differences in scope and emphasis between disciplines the knowledge integration is influenced by the degree of integrative understanding.

9.1. Recommendations

The recommendations consist of two parts. First, some practical recommendations to foster interdisciplinary research by explicating how to foster dialogue, trust, integrative understanding and knowledge integration. Second, recommendations for future research.

To increase dialogue one vital recommendation can help to establish a fruitful dialogue with one another. Dialogue could benefit from active managerial efforts to combine ideas, knowledge and researchers and appointing a group supervisor which steers on the process of dialogue. The process of dialogue can be steered by a group supervisor which helps to overcome habitual roles and polarization and to drop barriers between people. The group supervisor is responsible for the integration among project participants. A group supervisor can help to ask questions in order to inquire into oneself and someone else's assumptions, keeping track of the different containers and crisis. The group supervisor focusses on steering the process by asking questions to the group or summarizing what has come up so far and keeps track of the containers. Adding a group supervisor also influences the level of trust as working relationships can be managed in a more effective way.

Increasing trust in one another can be done by explicating what one requires in a project and also stating what one needs from other participants to make the collaboration work. In essence it is about communicating about the expectations of oneself, the other and the overall collaboration before the official start of the project. A face to face meeting that is guided by a managerial work package can help to foster trust in one another. The core point is to delve into aspects of what researchers deem essential to make the collaboration work and letting each other know why and what is required to achieve that degree of trust.

Fostering integrative understanding can be done by composing research proposals together, and therefore the recommendation is to host a meeting prior to the project start to discuss research proposals and how to include multiple insights. A meeting prior to the project start can help to mitigate the effects of fragmentation that can occur due to not knowing what some other disciplines can contribute to a certain research. The meeting is about exploring common ground and presenting essential aspects of different disciplines.

Time, language and commitment would benefit from active managerial input, a work-package that is responsible for the cross-module cooperation and has the means to intervene. First, managing how time is spend by organising meetings that incorporate both formal- and informal interaction. Meetings that evaluate on the overall knowledge integration would be beneficial and help to overcome problems that occur within the project. Second, these meetings can help to address the language problems by addressing that definitions are confounded with one another and help to make arrangements on what content per definition suits a specific case. Third, the present study shows that commitment to interdisciplinary research is present. However, it is shown that much of the present commitment has been put in collaborations within modules. Managing cross-module cooperation can help to mitigate the effects of these individualized approaches.

Knowledge integration in wicked problems such as Globaqua requires active managerial input incorporated and regulated via project design. The level of knowledge integration was hampered by the lack of integrational management, which can boost the integration between

epistemological different disciplines. By actively managing the informal- and formal interaction a higher degree of knowledge integration can be attained. Actively managing the integrative can help to overcome problems that are present for knowledge integration, issues such as confounding definitions and only working together with partners that show resemblance based on epistemological disposition.

The recommendations for future research are explicated in threefold. The three recommendations serve as guideposts to enhance the measurement of knowledge integration in future projects.

First, in order to refine the measurement of IDR one should note the provided categories in the analytical tool are rather large. IDR should be measured in smaller steps, research within the same domain and integrating some insights is a sign of IDR. Categorisation via mono-, multi-, inter-, and transdisciplinary research could leave less attention for research endeavours that incorporate small steps towards integration. For example an article that is in between monodisciplinary and multidisciplinary research does not benefit from this stark demarcation. Via the current theory it can be hard to discriminate what, albeit small, steps have been taken when integrating insights. Refining the tool to incorporate these small steps can help to overcome these big steps.

Second, the analytical tool requires further testing and tweaking by adding more categories. The second category regarding interactive research worked improperly. Testing if research steps have been taken interactively is hard to assess via articles as are synthesizing concepts and theories. Often it is not explicitly mentioned where the theoretical vantage point stems from and what combinations of theories, or fields, contributed to composing the article. Acquiring a better sense if the analytical tool works can be done by assessing output from other large-scale projects. Adding more categories could be beneficial for the reliability and measure things that aren't assessed before. Three major improvements are recommended. First, explicating the role of empirical and conceptual IDR. Interactive research was intended to capture the empirical dimension of IDR but proved to be inadequate and could not be measured based on the articles. Second, conceptual articles can be composed by a single mind and show traits of interdisciplinarity, or the other way around. The tested version of the tool does not capture this contradictory vantage point in IDR which was a flaw in design: the distinction between a single mind and relation between empirical and conceptual parts could not be explained. In other words, adding a category which adheres to empirical versus theoretical components and one that explicates the role of single versus team endeavours. Third, adding more categories improves the reliability and would help to balance the scores. For example, agreeing on S4 for the scope of IDR and S1 in the degree of integrative understanding would give 5 points. These statements are far apart and adding more categories provides balance through the cumulative scores.

Three, measuring IDR in multiple complex projects that show similarities to inquire into the development over a longer period of time. By incorporating multiple projects it is easier to track the small steps through which IDR develops, projects similar to Globaqua financed via EU funds. Perhaps successors of Globaqua funded with Horizon 2020 funds show similarities.

10. Literature

Azorín, J. M., Cameron, R. (2010). The application of mixed methods in organisational research: A literature review. *Electronic journal of business research methods, 8,* 2, 95-105.

Bark, R. H., Kragt, M. E., & Robson, B. J. (2016). Evaluating an interdisciplinary research project: Lessons learned for organisations, researchers and funders. *International Journal of Project Management, 34*, 8, 1449-1459.

Bammer, G., & OAPEN Foundation. (2013). Disciplining Interdisciplinarity: Integration and Implementation Sciences for Researching Complex Real-World Problems.

Chen, C-J., & Huang, J-W. (2007). How organizational climate and structure affect knowledge management—The social interaction perspective. *International Journal of Information Management, 27*, 104-118.

Cilliers, P. (2007) [1998]. Complexity and postmodernism: Understanding complex systems. London: Routledge.

Cilliers, P. (2001). Boundaries, hierarchies and networks in complex systems. *International Journal of Innovation Management, 5*(2), 135–148.

Dialogos. (2018). Retrieved from:

DoW. (2013). Description of work. Project acronym: Globaqua. Seventh Framework Programme.

Entman, R. M. (1993). Framing: Toward Clarification of a Fractured Paradigm. *Journal of Communication, 43*, 4, 51-58.

European Council (2000). Water Framework Directive: Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy. *Official Journal of the European Communities*.

Globaqua (2014). 1st Globaqua steering Committee and Advisory board meeting, composed by unknown.

Globaqua (2016). 2nd sampling campaign Barcelona notes, composed by unknown.

Globaqua (2017). 3rd General Assembly Sesimbra notes, composed by Tara Geerdink.

Globaqua (2018). Program website. Retrieved from: http://www.globaqua-project.eu/en/home/

Helling,A , Thomas, J.C. (2015). "6. Community dialogue" In The Transformative Power of Dialogue.

Hering, D. et al. (2010). The European Water Framework Directive at the age of 10: A critical review of the achievements with recommendations for the future. *Science of the Total Environment, 408*. 4007-4019.

Hulst, . M. J., & Yanow, D. (January 01, 2016). From Policy "Frames" to "Framing": Theorizing a More Dynamic, Political Approach. *American Review of Public Administration, 46,*1, 92-112.

Huutoniemi, K., Klein, J. T. Bruun, H. & Hukkinen, J. (2010). Analyzing Interdisciplinarity Typology and Indicators. *Research Policy, 39*(1), 79-88

Isaacs, W. N. (1993). Taking Flight: Dialogue, Collective Thinking, and Organizational Learning. *Organizational Dynamics, 22, 2*, 24.

Isaacs, W.N. (1999). Dialogue and the art of thinking together: A pioneering approach to communicating in business and in life. New York: Currency.

Isaacs, W.N. (2001) Toward an action theory of dialogue. *International Journal of Public Administration, 24*:7-8, 709-748, DOI: 10.1081/PAD-100104771.

Klein, J. T. (1990). Interdisciplinarity. History, Theory and Practice. Detroit: Wayne State University Press.

Klein, J. T. (2008). Evaluation of Interdisciplinary and Transdisciplinary Research: A Literature Review. *American Journal of Preventive Medicine, 35*(2S), S116-123.

Klein, J.T. (2017). Typologies of Interdisciplinarity: The Boundary Work of Definition. In Frodeman, R., In Klein, J. T., & In Pacheco, R. C. S. The Oxford handbook of interdisciplinarity. Oxford: Oxford University Press.

Klijn, E.H., J. Edelenbos, B. Steijn. (2010). Trust in governance networks: its impact on outcomes. *Administration and Society, 42*(2), 193–221. doi:10.1177/0095399710362716.

Kračun-Kolarević, et al. (2016). Evaluation of genotoxic potential throughout the upper and middle stretches of Adige river basin. *The Science of the Total Environment, 571*, 1383-91.

Kragt, M. E., Pannell, D. J., McVittie, A., Stott, A. W., Vosough, A. B., & Wilson, P. (2016). Improving interdisciplinary collaboration in bio-economic modelling for agricultural systems. *Agricultural Systems, 143*, 217-224.

Kruglanski, A.W. & Boyatzi L. M. (2012) The psychology of closed and open mindedness, rationality, and democracy. *Critical Review, 24*:2, 217-232, DOI: 10.1080/08913811.2012.711023.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C. J. (2012). Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustainability Science, 7,* 1, 25-4

Ledford, H. (2015). Team Science. *Nature, 525.* 308-311.

Lewicki, R. J., & Bunker, B. B. (1995). Trust in relationships: A model of development and decline. Columbus, Ohio: Max M. Fisher College of Business, Ohio State University.

Lewicki, R. J., & Bunker, B. B. (1996). Developing and maintaining trust in work relationships. Trust in organizations: Frontiers of theory and research, p 114-139.

MacKenzie, S.B., * Podsakoff, P.M. (2012). Common Method Bias in Marketing: Causes, Mechanisms, and Procedural Remedies. *Journal of Retailing, 88*, 4, 542-555.

McAllister, D. J., Lewicki, R. J., & Chaturvedi, S. (2006).Trust in developing relationships: from theory to measurement. *Academy of Management Proceedings, 1*.

Moyson S., van de Walle, S., & Groeneveld, S. (2016). In Edelenbos, J., Meerkerk, I. Critical reflections on interactive governance: Self-organisation and participation in public governance. Northampton, MA: Edward Elgar Pub.

Navarro-Ortega, A. et al. (2015). Managing the effects of multiple stressors on aquatic ecosystems under water scarcity. The GLOBAQUA project. *Science of the Total Environment 503–504*.

SRBMP. (2014). Sava River Basin Management Plan. International Sava River Basin Commission. Retrieved from: http://www.savacommission.org/srbmp/en/draft

Turner, S. Knowledge formations: An Analytical Framework. In Frodeman, R., Klein, J. T., & Pacheco, R. C. S. (2017). *The Oxford handbook of interdisciplinarity*.

Rein, M., & Schön, D. (1993). Reframing Policy Discourse. In F. Fischer & J. Forrester (Eds). (Ed.), The argumentative turn in policy analysis and planning (pp. 145–166). Duke University Press.

Roberts. C.N., (2015). Calls for dialogue. *In* The Transformative Power of Dialogue.

Siedlok, F., Hibbert, P., & Sillince, J. (2015). From practice to collaborative community in interdisciplinary research contexts. *Research Policy, 44*, 1, 96-107.

Slob, A., Jeffrey, P., Magnuszewski, P., & Pahl-Wostl, C. (2016). PSI-connect, Knowledge exchange in river basin management. In Martinuzzi, A., & Sedlacko, M (Eds). *Knowledge Brokerage for sustainable development, Innovative tools for increasing research impact and evidence-based policy making* (pp. 229-245). Greenleaf.

Slob, A., & Duijn, M. (2014). Improving the Connection between Science and Policy for River Basin Management. In Brils, J., Brack, W., Muller-Grabherr, D., Negrel, P. & Vermaat, J. E. (Eds.). *Risk-Informed Management of European River Basins. The Handbook of Environmental Chemistry.* Springer-Verlag Berlin Heidelberg, p. 347-364

Smitaite, J. (2016). Interdisciplinary Collaboration: Capturing a Progress of Scientific Knowledge Integration in Globaqua project.

Paliszkiewicz, O. J.(2011). "Trust Management: Literature Review," *Management, University of Primorska, Faculty of Management Koper, vol. 6*(4), 315-331.

Patton, M. Q. (2002). Qualitative Evaluation and Research Methods. Sage.

Vidmar, J. et al. (2016). Elements in water, suspended particulate matter and sediments of the Sava River. *Journal of Soils and Sediments 17,* 7. 1917-1927.

Van Meerkerk, I. F. & Slob, A. (2013). Scientific Knowledge Integration: Evaluation of the Interdisciplinary Process in ARCH. Project deliverable for the European (FP7) research project Architecture and roadmap to manage multiple pressures on lagoons (Arch).

Voulvoulis, N., Arpon, K. D., & Giakoumis, T. (2017). The EU Water Framework Directive: From great expectations to problems with implementation. *Science of the Total Environment, 575,* 358-366.

Wagner, C. S., Roessner, J. D., Bobb, K., Klein, J. T., Boyack, K. W., Keyton, J., Rafols, I., Börner, K. (January 01, 2011). Approaches to understanding and measuring interdisciplinary scientific research (IDR): A review of the literature. *Journal of Informetrics, 5,* 1, 14-26.

Appendix I

Measuring output via Globaqua articles – V6 2-7-18

Introduction to the analytical scheme

Dear participant of the GLOBAQUA research project,

The purpose of the present analytical scheme is to assess the output, that is journal articles, published within the Globaqua project. What we are looking for is knowledge integration across disciplinary boundaries. Monitoring of knowledge integration is part of the activities of WP 12 and will provide the overall project management, WP-leaders and module leaders feedback information on the progress of the integration process to reflect on the project. The analytical scheme consists of four questions. The first three questions require to fill in whether you disagree or agree with the presented statement. The first three questions consists of four statements, S1 -S 4. The fourth question asks for other journal indicators: the impact factor and the ranking of the journal where the article is published in. Summarizing is done to the table displayed on page four. Cumulate the answers to see how the read article scores on interdisciplinarity. This form can only be used to assess a single article, use a new form to assess other articles.

What article are you assessing? Fill in the reference or the DOI if you're accessing this analytical scheme digitally:

_____

1. **The scope of IDR. Please fill in what you think. Each statement can only be answered with disagree or agree, not with both. Please answer all statements.**

The scope of IDR	**Disagree**	**Agree**
S1) The present article only displays contributions from a single academical discipline.		
S2) The present article displays disciplinary insights from more than one academical discipline. However, these insights are not integrated.		
S3) The present article synthesizes knowledge from multiple disciplines. Collaboration within the same domain is executed, for example in the domain of natural sciences.		
S4) The present article combines findings from heterogenous academic disciplines, a combination between natural- and social sciences is used.		

2. **The degree of interactive research. Please fill in what you think. Each statement can only be answered with disagree or agree, not with both. Please answer all statements.**

Indicators for interactive research	**Disagree**	**Agree**
S1) Within the present article research is being conducted within mono-disciplinary teams. No other teams or departments contribute to the present article and empirical data, concepts and methodological approaches remain within team boundaries.		
S2) The present article shows that multiple teams contribute, yet the domain in which they operate is very much alike. For example cooperation among natural sciences OR among social sciences.		
S3) The present article shows that multiple teams collaborate and synthesizes or contrasts concepts, models, or theories from more than one field in order to develop new theoretical tools for interdisciplinary analysis. The contributing authors develop an integrated approach. The function of integration is to create links between fields, explore a new field of knowledge, or establish new paradigms. Models, concepts, or theories from more than one field are being used to stimulate integration across domains.		
S4) Have different research steps been interactively undertaken within the article? (problem formulation, framework, method, data collection, analysis and answering the research question)		

3. **The degree of integrative understanding. Please fill in what you think. Each statement can only be answered with disagree or agree, not with both. Please answer all statements.**

Indicators for integrative understanding	**Disagree**	**Agree**
S1) The present article uses vocabulary, i.e. concepts and language, merely borrowed from a single discipline. An empirical phenomenon is described in a unilateral way, through mono disciplinary language.		
S2) The present article uses vocabulary from disciplines that are alike. These concepts are still used for the purpose they are designed for and remain within the contributing disciplines.		
S3) The present article uses vocabulary to introduce concepts into a new context, i.e. borrowing concepts from one discipline to use them into another discipline.		
S4) The present article shows that a common vocabulary is established, the concepts forming the basis for the article are used in an integrated manner, a novel vocabulary to describe findings or concepts is used. The present article strives to go beyond the sum of the parts by the preceding concepts.		

4. **Journal Indicators. Please fill in on basis of the results you find on https://www.scimagojr.com/journalsearch.php?q= or the journal website. When accessing the website, fill in Journal Title, ISSN, or publisher name to acquire data regarding the impact factor and the ranking.**

Impact factor	The impact factor (IF) is a measure of the frequency with which the average article in a journal has been cited in a particular year. It is used to measure the importance or rank of a journal by calculating the times it's articles are cited, report the impact factor.	

Summarizing the results

Category 1-3 can be scored through with the rubric mentioned below. Answering questions with yes will only provide points. When a category is answered with disagree no points will be accredited.

Statement	**Accredited points**
S1	1pt
S2	2pt
S3	4pt
S4	8pt

Fill in the scores below.

Category	**Points**
Scope of IDR	
The degree of interactive research	
The degree of integrative understanding	
Total	

0-15 points – the article is monodisciplinary
16-30 points – the article is multidisciplinary
31-45 points – the article is interdisciplinary

Appendix II

Questionnaire 1 on knowledge integration in Globaqua

Introduction to the survey

Dear participant of the GLOBAQUA research project,

In the next pages you will find a questionnaire by which we will follow the progress of knowledge integration in GLOBAQUA. This monitoring of knowledge integration is part of the activities of WP 12 and will provide the overall project management, WP-leaders and module leaders feedback information on the progress of the integration process during the lifetime of the project.

The questionnaire will take about 10 minutes to fill in. Respondents will stay anonymous.

For more information about the survey, you can contact Adriaan Slob [adriaan.slob@tno.nl] or Tara Geerdink [tara.geerdink@tno.nl]

Questions to track the data

Explanation

The following questions are used to track the data in time. Respondents stay anonymous, only the questionnaires themselves are coded in order to follow the data! We will ask you to provide the first

letter of your father's and mother's name. Together with the year of birth we are able to code the questionnaire.

1. What is the first letter of your father's first name. Please circle one of the letters below

A—B—C—D—E—F—G—H—I—J—K—L—M—N—O—P—Q—R—S—T—U—V—W—X—Y—Z

2. What is the first letter of your mother's first name. Please circle one of the letters below

A—B—C—D—E—F—G—H—I—J—K—L—M—N—O—P—Q—R—S—T—U—V—W—X—Y—Z

3. What is your year of birth? (only the last two numbers; 1978 = 78)

General control questions

4. What is your sex?

Male

Female

5. Broadly defined, I consider myself a

Natural scientist

Social scientist

6. What is your disciplinary background? Please tick one category: choose the disciplinary category in which you are mostly educated.

Physical sciences (includes hydrology, physics, earth sciences, chemistry)

Life sciences (includes biology, genetics, medical sciences)

Environmental sciences

Engineering

Social sciences (includes economics, sociology, political science, psychology)

Humanities (includes philosophy, history, arts)

Other, please specify

7. How many years of experience do you have in interdisciplinary research projects?

….. year(s)

8. In which module are you most actively involved?

Module 1 Stressors

Module 2 Receptors

Module 3 Implications

Module 4 Environmental Management

Module 5 Project coordination and dissemination

9. In which work package(s) are you mainly participating? (Multiple answers possible)

WP 1	Data	WP 8	Services
WP 2	Scenarios	WP 9	Socioecon
WP 3	Hydrolog	WP 10	Valuation
WP 4	Geomorph	WP 11	Integration
WP 5	Qualitychem	WP 12	Policy
WP 6	Biol	WP 13	Dissemination
WP 7	Ecosystem	WP 14	Manage

Questions on knowledge integration in GLOBAQUA

Explanation

The following questions are all about knowledge integration and interdisciplinary research, research which is based on active interaction across disciplinary fields.

10. Please rate the following statements about interdisciplinary research orientation. Please rate all statements.

Interdisciplinary orientation in GLOBAQUA (personal)	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
In my own work for GLOBAQUA, I typically incorporate perspectives from disciplinary orientations that are different from my own					
Although I am trained in a particular discipline, I devote much of my time in GLOBAQUA to understanding other disciplines in order to inform my research for GLOBAQUA					
I would describe myself as someone who strongly values interdisciplinary or transdisciplinary collaboration					
In my own work for GLOBAQUA, I'm strongly oriented towards learning from other disciplines					

11. Please indicate to what extent you agree with all of the following statements about the interdisciplinary research orientation of other participants in GLOBAQUA.

Interdisciplinary orientation in GLOBAQUA (other participants)	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
The other participants in GLOBAQUA recognize the added value of my discipline					
The other participants in GLOBAQUA recognize the expertise from my discipline					

The other participants in GLOBAQUA are open to learn from my discipline					
GLOBAQUA members as a group are open-minded about considering research perspectives from fields other than their own					

12. Please indicate to what extent you agree with the following statements on the interaction/ interdisciplinarity in GLOBAQUA.

Degree of interactive research in GLOBAQUA	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
In GLOBAQUA there is a lot of interaction between different disciplines					
In GLOBAQUA much time is spend on understanding other disciplines					
In GLOBAQUA research methods from different disciplines are integrated					
In GLOBAQUA theories and models from different disciplines are integrated					

13. Please indicate to what extent you agree with the following statements on the degree of understanding between different disciplines that has been achieved in GLOBAQUA up till now

Degree of integrative understanding in GLOBAQUA	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
Up till now, GLOBAQUA helped in developing a common understanding between the disciplines					
Up till now, GLOBAQUA helped in developing shared concepts between the disciplines					
Up till now, GLOBAQUA helped in developing a shared framework between the disciplines					

14. Please indicate to what extent you agree with the following statements about the atmosphere during the general assembly meeting

Atmosphere during the General Assembly	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
The atmosphere during the meeting has been comfortable					
The other participants were willing to listen to my contributions					
There was enough time for discussing ideas with other team members					
The meeting helped me to get to know the other participants better					
I feel comfortable to show limits or gaps in my knowledge to the other participants					

15. Please indicate to what extent you agree with the following statements about the extent in which GLOBAQUA has contributed to interdisciplinary learning

Effectiveness of GLOBAQUA in advancing understanding	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
I think that interdisciplinary research among GLOBAQUA participants will lead to valuable scientific outcomes for river based management that would not have occurred without collaboration					
Generally speaking, I believe that the benefits of interdisciplinary research within GLOBAQUA outweigh the inconveniences and costs of such work					
GLOBAQUA helped me to learn from other disciplines					
GLOBAQUA has improved my understanding of other disciplines					
GLOBAQUA has improved my appreciation of other disciplines					

GLOBAQUA has improved my integrative understanding of water issues					

16. Please indicate to what extent you agree with the following statements about the challenges in collaboration between different disciplines in GLOBAQUA

Challenges	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree
Conflicts between disciplinary perspectives on river based management are frequent in GLOBAQUA					
There is a high level of competition among the disciplinary groups in GLOBAQUA					
Collaboration between different disciplines has posed a significant time burden in my research for GLOBAQUA					
Up till now, collaboration between different disciplines in GLOBAQUA has not been productive					

17. What are to your opinion the main challenges in the cooperation between different disciplines in GLOBAQUA so far?

18. What have you learned from the collaboration with other disciplines in GLOBAQUA so far?

19. On a scale from 1 to 10, how would you rate this General Assembly meeting? Please elaborate why

1	2	3	4	5	6	7	8	9	10

Thank you for filling out this questionnaire!

Appendix III

Module 1 Stressors									
1	2	4	9	10	11	12	14	15	18
19	21	24	26	27	29	35	38	39	40
45	46	49	50	52	53	56	58	59	60
61	64	65	67	68	70	71	73	75	77
78	79	80	86	89	91	92	93	96	100
102	103	104	105	109	111	113	114	118	119
120	122	126	128	129	131	132	133	134	
Module 2 Receptors									
3	5	13	16	17	29	22	23	25	28
30	31	32	34	37	41	42	43	44	47
48	51	55	57	62	63	66	69	72	76
81	84	85	87	88	90	94	97	98	99
101	106	107	108	110	112	115	121	123	124
130									
Module 3 Implications									
36	54	82	95						
Module 4 Environmental management									
33	74	83	116	117	125	127			
Module 5 Project coordination and dissemination									
6	7	8							

The table shows what articles are scored per module, as composed by the author.