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Transdisciplinary Research and Development Cooperation: Insights from the First Phase of the Palestinian-Dutch Academic Cooperation Programme on Water

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Abstract: Transdisciplinary research offers a promising approach to development cooperation programs by integrating knowledge from academic and non-academic stakeholders, and from natural and social sciences. In the context of development research on water, there is little evidence on how stakeholder involvement takes place in the three stages of transdisciplinary research (problem definition, knowledge production, and knowledge application). This paper aims to create empirical evidence and insights on this question based on the Palestinian-Dutch Academic Cooperation Programme on Water (PADUCO). Six research projects, which have been implemented within the first phase of PADUCO, were examined using the data collected through a survey and document reviews. The results show that research problems were defined according to societal needs and contextual factors. Research teams were multidisciplinary and included non-academic members, whereas the institutional involvement of non-academic stakeholders was limited and unbalanced between the governmental and non-governmental actors. Although the application of the knowledge produced was mainly focused on academia, opportunities for broad dissemination were utilized, albeit to a limited extent. Finally, there was a lack of monitoring and evaluation of impacts, which is explained by the budget and time limitations of such small-scale projects and can be mitigated by programme-level measures.

Keywords: transdisciplinarity; transdisciplinary research; development cooperation; water; Palestine; The Netherlands

1. Introduction

The value of development cooperation is acknowledged in creating sustainable solutions to increasingly complex problems of developing countries and regions [1]. This type of cooperation often aims to improve the capacities of individuals and organizations in the target country by transferring technical knowledge. International organizations as well as countries in the Global North have been implementing development cooperation project programs in developing countries, and often focusing on few target sectors, such as water, food, and health, etc. Contextual barriers such as the limited applicability of knowledge, and the political fragility and conflict in the target country can hinder capacity development at various levels. Multi-level and contextualized approaches are thus needed in the planning and implementation of capacity improvement programs as part

of development cooperation policies. Transdisciplinary research methodologies can provide such an approach through incorporating the knowledge from academic and non-academic stakeholders and from natural and social sciences [2,3]. Transdisciplinarity is particularly relevant in the context of sustainable development, since it addresses the complexity associated with the social, economic, and environmental dimensions of sustainable development [4,5].

The above aims and challenges of development cooperation also apply to the water sector and water-related research. Within the context of water management and governance, knowledge exchange and transfer among countries has become a common practice in the past decades. Concepts such as ‘integrated water resources management’, ‘participatory water management’ and ‘good water governance’ have been promoted through various international cooperation projects, some of which have been driven by donor countries or international funding organizations [6]. Additionally, the co-production of knowledge on water through transdisciplinary research is shown to play an increasingly important role in water policy and governance processes [7–10].

Transdisciplinarity is defined as “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” [11] (pp. 26–27). Interdisciplinarity and multidisciplinary are similar to transdisciplinarity in the sense that they also bring together knowledge from multiple scientific domains. However, the integration of societal, and often non-academic, knowledge distinguishes the transdisciplinary approach from interdisciplinary and multidisciplinary approaches. Starting from a complex and socially relevant problem, transdisciplinary research aims to enable mutual learning among different scientific disciplines as well as between researchers and societal actors [4,11]. The research is then expected to yield both scientific outputs, such as scientific insights, and societal impacts, such as changes in the practical knowledge and decision-making capacity of stakeholders [12]. Transdisciplinary research projects are typically subdivided into three key stages [4,11,13]:

- **Problem definition:** The societal problem is identified and related to a scientific challenge. The resulting research scope and objectives are defined, as well as the analytical frameworks and methods that are applied over the course of the research project.
- **Knowledge production:** The research is realized with clearly assigned roles of all researcher team members and other stakeholders involved in the project. Interdisciplinary cooperation is also emphasized between different actors.
- **Knowledge application:** Research results are assessed and disseminated in a suitable manner to the stakeholders within and outside of the research team. The societal impact of the research results is evaluated on a medium- to long-term basis.

A key barrier to transdisciplinary development research, which takes place within the context of development cooperation programs, is the limited collaboration and understanding among different stakeholders on the complex problems that lie at the heart of development cooperation programs. Resulting challenges include the blurred boundaries of the system under consideration and the trade-off between contextualizing and generalizing the knowledge produced [14]. Therefore, it is crucial to actively involve stakeholders from relevant sectors in all stages of transdisciplinary research [15]. Participation of individual public members and organized stakeholders in water management and governance has been receiving attention from theoretical, methodological, and practical perspectives [16,17]. However, within the scholarly literature on transdisciplinary development research on water, there is little evidence on the involvement of different types of academic and non-academic stakeholders throughout the three stages of transdisciplinary research projects (cf. Bahadir and Dichtl [18], who emphasize capacity building in water management through international research collaboration, without reflecting on its transdisciplinary implications). Our paper aims to bridge this knowledge gap by addressing the question of how stakeholder involvement takes place throughout the three stages of the transdisciplinary water research projects. To answer this

question, we collected empirical data from the transdisciplinary water research projects included in the Palestinian-Dutch Academic Cooperation Programme on Water (PADUCO), a long-term research program that is funded as part of the Dutch development cooperation policy in the State of Palestine. In the remaining sections of the paper, we first provide background information about PADUCO, describe the sources of data and the data collection and analysis process, and reflect on the limitations of the materials and methods used. Then we present and discuss the results of the analysis along the three stages of transdisciplinary research. We conclude with a reflection on the broader implications of our empirical findings for improving transdisciplinary development research on water, and the identification of avenues for future research.

2. Materials and Methods

2.1. Background Information about PADUCO

PADUCO has been initiated in 2012 by a consortium of Palestinian and Dutch universities. The program is funded by the Dutch Ministry of Foreign Affairs, for a first phase (PADUCO-1), which has been implemented between December 2013 and April 2016, and the second phase (PADUCO-2), which is ongoing since October 2016 and will continue until December 2019. Both PADUCO-1 and PADUCO-2 are driven by the motivation to improve the individual, organizational, and institutional capacities in the Palestinian higher education and water sectors by implementing research, education, and training projects. PADUCO-2 builds on the results and the lessons learnt from PADUCO-1, and maintains the academic consortium of to a large extent towards establishing a long-term partnership. It also addresses the research priorities of the three most relevant governmental organizations Palestine, namely the Palestinian Water Authority, the Environmental Quality Authority, and the Ministry of Agriculture.

This paper focuses on PADUCO-1, which involved five Palestinian universities (An-Najah National University, Al-Quds University, Birzeit University, Palestinian Polytechnic University, Palestine Technical University Kadoorie) and five Dutch universities (Delft University of Technology, IHE Delft Institute for Water Education, Maastricht School of Management, University of Twente, Wageningen University and Research). The overall objective of PADUCO-1 was defined as “contributing to the effectiveness of the Palestinian water sector regarding the development, provision and management of water resources and services” [19] (p. 6). One of PADUCO-1’s intended impacts was to improve the link between the scientific research carried out by Palestinian universities and practical applications on the ground. This was sought through projects based on case studies, which targeted specific localities in the West Bank, and applied research on existing problems of the Palestinian water sector [19]. Transdisciplinary research approaches were thus highly relevant to the program’s objectives. Figure 1 shows the main water resources of Palestine and the major cities in the West Bank and Gaza Strip.

PADUCO-1 consisted of three interrelated clusters, namely education, training, and research, which were supported by a program management workpackage. This paper focuses on the research cluster, which included eleven small-scale research projects. These projects were funded due to their relevance for policy and practice in the Palestinian water sector and the inclusion of a higher education component in the form of joint supervision of master students [20]. Within PADUCO-1, the research projects focused on one of four key research themes that were identified by the consortium partners in line with the scope and objectives of the program: ‘Non-conventional Water Resources’ (five projects), ‘Water Quality, Sanitation and Public Health’ (two projects), ‘Water Management and Governance’ (two projects), and ‘Water and Agricultural Production’ (two projects) [19].



Figure 1. Main water resources of Palestine (Source: water.fanack.com/palestine/water-resources).

2.2. Data Collection and Analysis

This paper examines six out of the eleven research projects implemented within PADUCO-1, including two projects per research theme (See Table 1). The projects were selected based on their completion within the timeframe of PADUCO-1 and to ensure the representation of all consortium partners involved in PADUCO-1 in order to limit any bias from individual preferences towards or against transdisciplinarity. The theme, ‘Water Quality, Sanitation and Public Health’, was not included in the analysis, since one of the two projects in this research theme could not be implemented due to external circumstances. An equal number of projects were selected from each research theme to avoid a bias to the results based on the predominantly technical nature of the theme ‘Non-conventional Water Resources’, which included five projects in total.

Table 1. Research projects of PADUCO-1 that are included in the analysis.

Research Project	Research Theme	Research Team Members	Survey Respondents
Potential Artificial Recharge Sites along Wadi Al Faria Basin	Non-conventional Water Resources	7	4
Treatment of Olive Mill Waste at Rural Areas in the West Bank	Non-conventional Water Resources	5	3
Re-thinking the Water Governance Systems to Cope with Water Scarcity	Water Management and Governance	10	6
Evaluation and Assessment of Groundwater Resources in the Eastern Aquifer	Water Management and Governance	5	3
Development of Agricultural Best Management Practices to Preserve Groundwater Quality	Water and Agricultural Production	6	3
Improving Crop Yield and Production of Rainfed Agriculture in the Jenin Governorate	Water and Agricultural Production	14	6

In order to answer the research question, empirical data was collected between November 2017 and February 2018 through an online survey and the examination of documents related to the PADUCO program and individual projects. In December 2017, the survey was sent to 47 potential respondents; i.e., all research team members involved in any of the six projects. Potential respondents were given three weeks to fill in the survey. While the completion of the survey was voluntary, multiple reminders were sent to increase the response rate. Respondents that participated in several projects were asked to fill in the survey for only one project. The selection of these projects was made by the authors based on the availability of potential respondents in similar roles within the projects in question. This situation applied to two researchers. The total number of unique potential respondents was therefore 45.

In accordance with the focus of the research question, the survey included questions on stakeholder involvement in the three stages of transdisciplinary research projects; i.e., problem definition, knowledge production, and knowledge application. Survey questions were primarily phrased as single or multiple choice questions and likert matrix questions. For some questions the respondents had the option to elaborate further on topics of interest, such as the evaluation of project impacts (Please see Appendix A for a summary of the survey questions). As listed in Table 2, the different stakeholder groups that were referred to in the survey were pre-defined in order to ensure consistent interpretation by the respondents.

Table 2. Definition of different stakeholder groups used in the survey.

Stakeholder Group	Definition
Research team	University staff and students working on the research project
Academia	Researchers at universities who are not directly involved in the research project
Government	Officials employed by government agencies, such as the Palestinian Water Authority, the Ministry of Agriculture or the Dutch Ministry of Foreign Affairs
Private sector	Private companies that are relevant to the research topic or project
Civil society	Non-governmental organizations and initiatives, such as environmental organizations, grassroot initiatives and independent knowledge institutes
Citizens	Communities or groups or people local to project sites or in some other way relevant to the research project, such as farmers or households, who participate in research in their individual capacities

As shown in the last two columns of Table 1, a total of 25 respondents completed the survey, which corresponds approximately to a 50% response rate for each project. The group of survey respondents reflects the distribution of gender and of geographic location (Palestine vs. Netherlands) in the pool of potential respondents (Tables 3 and 4).

Table 3. Gender distribution of potential and actual survey respondents.

Gender	Potential Respondents	Actual Respondents
female	9	6
male	36	19

Table 4. Affiliation of potential and actual survey respondents.

Affiliation	Potential Respondents	Actual Respondents
Palestinian organization	26	16
Dutch organization	19	9

Twenty-two of the respondents indicated that they had an active role in the research, including seven master students that were involved in the projects to carry out their MSc thesis research,

while three respondents were primarily involved in a less active role such as the supervision of student theses. For each project, the group of respondents featured at least one researcher involved in initial project design and planning process and in project management. Table 5 shows a further breakdown of the different roles within the project research teams and their academic or non-academic background. The team members are sub-divided into four categories:

- (1). Project applicants that took the lead in designing and coordinating the research projects and had, with one exception that was from a civil society organization, tenured positions at Dutch or Palestinian partner universities (11 individuals),
- (2). Team members that are working in a university (5 individuals),
- (3). Team members that are working in a non-academic institution, such as governmental and non-governmental organizations, private companies, and independent knowledge institutes (2 individuals),
- (4). Master students (7 individuals). Almost all research projects within PADUCO-1 included master students as core members of their research teams in connection with the partial focus on higher education within the PADUCO program. Therefore, the master students constitute a significant group within the respondents.

Table 5. Representation of the different roles within the project teams (Numbers indicate the actual respondents in each category, with the number of potential respondents in brackets).

Research Project	Project Applicants	Academic Team Members	Non-Academic Team Members	Master Students
Potential Artificial Recharge Sites along Wadi Al Faria Basin	2 (3)	0 (1)	0 (0)	2 (3)
Treatment of Olive Mill Waste at Rural Areas in the West Bank	2 (3)	1 (1)	0 (1)	0 (0)
Re-thinking the Water Governance Systems to Cope with Water Scarcity	1 (2)	1 (2)	1 (2)	3 (3)
Evaluation and Assessment of Groundwater Resources in the Eastern Aquifer	2 (2)	1 (1)	0 (1)	0 (0)
Development of Agricultural Best Management Practices to Preserve Groundwater Quality	1 (2)	1 (2)	1 (1)	0 (1)
Improving Crop Yield and Production of Rainfed Agriculture in the Jenin Governorate	3 (4)	1 (2)	0 (6)	2 (2)
Total	11 (16)	5 (9)	2 (11)	7 (9)

Survey responses were stored and analyzed anonymously. Due to the small sample size, responses were primarily treated as qualitative rather than quantitative data. In addition to the survey, a range of documents that were produced at the program and project levels were examined. These documents included the proposals of the six projects, 20 project deliverables, such as research reports, scientific articles and student theses, and eight program documents such as the initial funding proposal, progress reports and the program review report. Documents were provided either directly by survey respondents or by the two country coordinators of PADUCO-1, who are the first and third co-authors of the paper. To prevent any bias regarding the personal views of the country coordinators, who were also responsible for preparing most of the program-level documents, their contribution to data collection and analysis has been limited to providing the available documents and participating in the survey as research team members. The analysis of the data from the survey and documents has been mainly undertaken by the second author.

2.3. Limitations of the Materials and Methods

The sample analyzed in this paper includes six out of the eleven research projects that were part of PADUCO-1. While this approach was taken to maintain the same number of projects per thematic cluster (Table 1), it adds a selection bias, particularly within the 'Non-conventional Water Resources' cluster which included five projects in total. Another bias was introduced by the survey respondents.

While almost all projects included non-academic team members, only two of the survey's respondents were not affiliated with universities. This bias originates in part from the fact that contact data was not always available for non-academic team members and could not be provided by other team members. Additionally, project leaders and students were the most responsive groups, with rates of 100% and 87%, respectively. Both of these groups are, by their nature, exclusively comprised of persons affiliated with universities.

In order to limit the impact of the bias introduced by the survey, the responses were cross-checked with information given in project documents and deliverables. A considerable number of documents were supplied by the PADUCO coordinators and by the project leaders themselves. However, due to financial and instructional constraints within PADUCO-1, there was no standard way for the dissemination of project results across the program and no central directory to access documents on all research projects. Therefore, individual deliverables of projects might have been left out of consideration due to a lack of access.

3. Results

The results of the analyses are presented in the following subsections along the three stages of transdisciplinary research, which are described in Section 1. Key aspects of the problem definition stage include the societal problems and corresponding research objectives, the target groups of projects, and stakeholder involvement in this phase. The analysis of the knowledge production stage focuses on the composition of research teams, stakeholder involvement in this phase, communication mechanisms, and conflict resolution and reflection processes. Lastly, regarding the knowledge application stages, the various types of project outputs and their corresponding target groups, the knowledge dissemination strategies of the project team, and follow-up activities are analyzed.

3.1. Problem Definition

3.1.1. Societal Problems vs. Research Objectives

All project proposals distinctively outline a societal problem as part of their research description. In line with the local context of Palestine, these problems predominantly refer to the limited availability of and access to water resources and the expected further decrease due to climate change as well as to environmental pollution caused by resource mismanagement. In transdisciplinary research, the societal problem is transformed into research objectives based on a collaborative process between researchers and stakeholders that defines the scope and key questions to be answered by the research project [11]. The societal problems and related research objectives of each PADUCO project as presented in the project proposals are summarized in Table 6.

Table 6. Societal problem and research objective identified in each project proposal.

Research Project	Societal Problem	Research Objective
Potential Artificial Recharge Sites along Wadi Al Faria Basin	Overexploitation and limited natural recharge of groundwater resources threaten the sustainability of the agricultural sector in the study area	Identify potential artificial recharge sites in the Wadi Al Faria Basin
Treatment of Olive Mill Waste at Rural Areas in the West Bank	Poor waste management in olive oil production facilities has led to severe environmental pollution in different places in the West Bank	Identify an optimal strategy to biodegrade high-strength olive-mill wastewater
Re-thinking the Water Governance Systems to Cope with Water Scarcity	The Palestinian water governance system is increasingly challenged by water scarcity and military occupation	Produce and exchange policy knowledge on effective ways of coping with water scarcity

Table 6. Cont.

Research Project	Societal Problem	Research Objective
Evaluation and Assessment of Groundwater Resources in the Eastern Aquifer	The water table in wells across the West Bank has significantly dropped over the past years	Assess and evaluate the available groundwater resources through hydrological modelling of the Eastern Aquifer
Development of Agricultural Best Management Practices to Preserve Groundwater Quality	Insufficiently controlled and managed agricultural practices contribute to the deterioration of groundwater quality in Palestine	Assess the environmental impacts of uncontrolled agricultural practices and identify cost-effective best management practices
Improving Crop Yield and Production of Rainfed Agriculture in the Jenin Governorate	The livelihood of Palestinian farmers is threatened by their high dependence on rainfall at times of climate change	Study the impact of climate change on rainfed crops and improve the adaptive capacity of the agriculture sector in the Jenin Governorate

While the research proposals underline the societal relevance of all projects, most researchers stated in their responses that their projects were motivated by prior experience in the field or professional interest in the specific topic rather than societal demand from stakeholders outside of academia. Researchers involved in the project ‘Potential Artificial Recharge in the Wadi Al Faria Basin’ were the only ones to indicate a non-academic initiative as impulse for the project, namely the interest of various civil society actors.

3.1.2. Target Groups of Projects

According to the survey results, all projects were targeted at government actors and the scientific community, whereas the latter involves the research team itself and academia at large. The private sector was identified as target group in four projects, and the civil society in two projects, the Potential Artificial Recharge project that was motivated by the interest from the civil society being one of them. Local citizens were only considered as a target group of the two research projects in the Water and Agricultural Production research theme. The survey responses compare well to the target groups that were explicitly or implicitly identified in the different project proposals (Table 7). The key difference is the higher priority given in the project proposals to the involvement of local organizations, particularly farmer associations. As compared to the survey responses, project proposals also put less emphasis on the research team itself as a target group.

Table 7. Target groups that were identified by survey respondents and highlighted in the project proposals.

Research Project	Target Groups Identified by Survey Respondents	Target Groups Highlighted in the Project Proposal
Potential Artificial Recharge Sites along Wadi Al Faria Basin	Research team, government, civil society, private sector	Government, local village councils and farmer associations, civil society, private sector
Treatment of Olive Mill Waste at Rural Areas in the West Bank	Research team, government, private sector	Academia, government, farmer associations, private sector
Re-thinking the Water Governance Systems to Cope with Water Scarcity	Research team, academia, government	Government, private sector
Evaluation and Assessment of Groundwater Resources in the Eastern Aquifer	Research team, academia, government, private sector	Research team, government, private sector

Table 7. Cont.

Research Project	Target Groups Identified by Survey Respondents	Target Groups Highlighted in the Project Proposal
Development of Agricultural Best Management Practices to Preserve Groundwater Quality	Research team, academia, government, citizens	Government, farmer associations
Improving Crop Yield and Production of Rainfed Agriculture in the Jenin Governorate	Academia, government, civil society, citizens, private sector	Government, farmer associations, civil society, private sector

3.1.3. Stakeholder Involvement in Problem Definition

Despite the fact that non-academic target groups and stakeholders were identified for each project and the respective societal problems, the overall problem definition was predominantly made by the research teams. The highest level of stakeholder involvement in the process of determining the research objectives was reported for the broader selection of the research topic, in which three out of six projects involved most the stakeholders identified as target groups. More detailed steps, such as choosing a specific geographic area or a technology to focus the research on, identifying the research questions and selecting the research methods, generally remained the sole responsibility of the research team with occasional input from stakeholders. The project focusing on Rainfed Agriculture in the Jenin Governorate was the sole project to include broad stakeholder involvement throughout all steps of the problem definition. This was also the only project in which the research team did not indicate itself as a target group of the research.

3.2. Knowledge Production

The composition of the research team and the clarification of the roles of the researchers themselves as well as of stakeholders that are included at different instances throughout the research process are an important foundation for transdisciplinary knowledge production [4].

3.2.1. Composition of Research Teams in Terms of Academic and Non-Academic Members

Survey respondents indicated that their teams predominantly consisted of participants from academia, with occasional mention of team members from different sectors, mainly including water and agriculture. The list of research team members in the project proposals underlined the dominance of academic affiliations among the researchers, but also showed the involvement of non-academic individuals in almost all projects, albeit in varying capacity. The project on Agricultural Best Management Practices involved a representative of the Palestinian National Agricultural Research Centre, who actively contributed to the development of agricultural guidelines and was responsible for the implementation of training programs following up with the research project. The Olive Mill Waste Treatment team involved an employee of the olive oil mill that was chosen as pilot study within the research. This team member was primarily responsible for the implementation of the devised treatment system on site, but, according to the proposal, not involved with the experimental research resulting in the pilot system. The research team working on Rainfed Agriculture in the Jenin Governorate was the largest group, comprising of 14 members. Six of these members came from non-academic institutions, including both government officials and consultants at independent research institutes. They were mostly tasked with the provision of data and technical assistance, only one Dutch consultant had a more extensive role as part of an institutional cooperation. While the previous projects included individual non-academic members in their research teams, the proposal for the Evaluation and Assessment of Groundwater Resources also lists three organizations—a Dutch consultancy for fellowships and technical visits, and the Palestinian Water Authority and the Palestinian Meteorological Department for data provision and project monitoring and evaluation. The Applied Research Institute Jerusalem, a Palestinian organization, took an active role in this project, providing two of the main researchers.

3.2.2. Composition of Research Teams in Terms of Disciplines

In his review of the scope of the projects, Heun [20] (p. 5) argues that “practically all” research projects of PADUCO-1 could be classified as mono-disciplinary and predominantly technical. The composition of the research teams themselves, however, gives a more multidisciplinary impression. Researchers were asked to indicate which scientific discipline(s) their work belongs to. Grouped into the four categories engineering, management sciences, natural sciences, and policy sciences (Figure 2), the responses show that all project teams included expertise from at least two, and in most cases three, disciplinary categories.

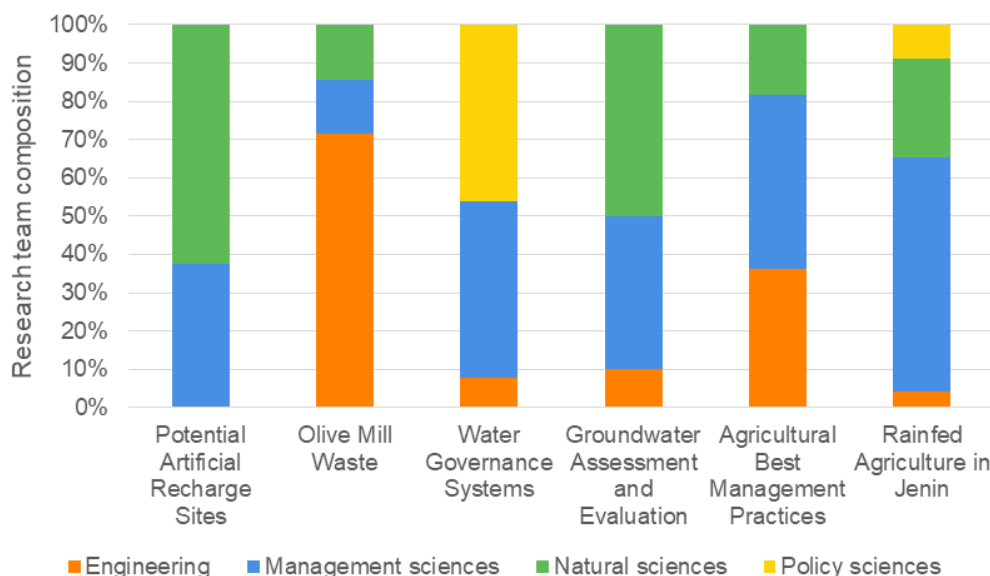


Figure 2. Composition of research teams by disciplinary categories.

A further breakdown on the disciplinary focus shows that the most commonly mentioned disciplines across all projects were water management, agriculture, environmental engineering, geosciences and hydrology. An overview of the individual disciplines indicated by survey respondents is given in Table 8.

Table 8. Disciplines per category as mentioned by the respondents (Number of mentions are shown in brackets).

Engineering	Management Sciences	Natural Sciences	Policy Sciences
	Water management (13)		
	Agriculture (8)		
Environmental engineering (6)	Environmental management (5)	Geosciences (5)	Policy science (4)
Water engineering (4)	Economics (2)	Hydrology (5)	International relations (2)
Chemical engineering (1)	Management science (2)	Environmental science (4)	Sociology (1)
Civil engineering (1)	Agronomy (1)	Hydrogeology (4)	Water governance (1)
	Environmental health (1)	Geography (1)	
	Urban planning (1)		

Interaction with researchers from other scientific disciplines was seen as satisfactory and sufficient to reach the project goals by most respondents. Four respondents, all from different projects, indicated that the exchange was definitely or probably not sufficient to reach the intended outcomes; two of them also stated that there was no opportunity for any interaction with other disciplines to begin with.

3.2.3. Stakeholder Involvement in Knowledge Production

Outside of the research team, stakeholders were generally involved in the knowledge production process as sources of information or feedback. In the survey responses, the governmental actors were commonly mentioned as sources of information, most notably as interviewees or through the provision of data, followed by actors from academia and the private sector. Civil society organizations and individual citizens were rarely mentioned, while they were primarily included in the two projects on Water Governance Systems and on Artificial Recharge Sites. Feedback on the research process and outcomes was largely sought from academia and governmental actors in all projects. In contrast to the high emphasis that the survey respondents placed on governmental and private sector actors, Heun [20] reported a very limited participation of the private sector and the Palestinian ministries, with government officials deploring a lack of information received from the research projects. This indicates a discrepancy between the role that the researcher team members attributed to non-academic stakeholders as sources of information in the data collection process and the more active role that the non-academic stakeholders expected to take.

3.2.4. Communication within the Teams and with External Stakeholders

In-person meetings and remote contacts via phone or Skype calls and emails were the key communication channels that were used by all project teams. Workshops were organized around milestones in the project schedule to enhance in-person contact. The projects on Water Governance Systems and Rainfed Agriculture in Jenin were the only ones to involve stakeholders from outside of the research team in these workshops, thereby utilizing them to receive feedback on the project process and outputs. The frequency of contact with different groups of stakeholders varied widely between different members of the respective research teams, depending on individual assignments and responsibilities. Considering communication in the PADUCO program as a whole, Heun [20] (p. 5) notes that “a fair number of remarks on the lack of communication [. . .] between partners at different levels: (1) between Palestinian and Dutch partners, (2) between partners within a country, (3) within universities and (4) between academia and the ministries, represented in committees [. . .]”.

3.2.5. Conflict Resolution Within the Research Teams

Given the involvement of various stakeholders from different scientific and non-scientific backgrounds, transdisciplinary researchers need to be aware of emerging conflicts within the research team and able to manage these conflicts [11]. Researchers from three different projects reported conflicts throughout the research process; one of these cases was limited to minor disagreements on research approaches both within the research team and with other stakeholders. The Water Governance Systems and Agricultural Best Management Practices, however, indicated more significant conflicts between the respective research teams and government stakeholders on the reliability of data provided by government agencies. While the Water Governance Systems team resolved the issues via meetings and discussions with the relevant stakeholders, none of the members of the Agricultural Best Management Practices indicated any steps towards conflict resolution in their survey answers. An additional conflict between research team members of the Water Governance Systems project was reported, which revolved around the theoretical framework and communication. As it was reportedly not possible to settle the differences between the researchers involved in this conflict, interactions between them were limited for the remainder of the project duration.

3.2.6. Learning Processes via Reflection Throughout Knowledge Production

In order to assess the occurrence of learning processes throughout the knowledge production stage, researchers were asked to rate the possibilities to reflect on the progress during three the data collection, data analysis and reporting steps. Most researchers indicated a high or moderate amount of opportunities to reflect on insights from the research. In approximately half of the cases reported by

respondents, reflections indeed led to changes to the research project. Most changes were made to the methodology, followed by the involvement of scientific disciplines, and the least changes were made to the research objectives. No significant difference was observed between the three steps.

Respondents indicated that large-scale changes to the scope of the research projects were rare. A key alteration was, however, made to the project on Water Governance Systems. The research was initially supposed to include a comparison between water governance systems in Palestine, Jordan, and Turkey. As the project team ran into problems with recruiting Dutch master students to complete their theses within the project and to conduct country analyses on Jordan and Turkey, this part of the project was canceled, limiting the knowledge production based on the data collected in Palestine.

3.3. Knowledge Application

Besides the dynamic and inclusive research process itself, generating societal and scientific impact is one of the key goals of transdisciplinary research [21]. The dissemination of scientific and non-scientific project outputs and additional activities to follow up with research projects in order to ensure the application of research outcomes in practice are therefore of crucial importance to a project's success [12].

3.3.1. Project Outputs and Their Target Groups

The production of non-scientific outputs alongside of scientific deliverables and the dissemination of research results to non-academic stakeholders take a central role in each of the examined project proposals. According to the final reports that the project teams submitted to the program management, the key project outputs produced by the research teams were project reports, scientific articles and student theses. While almost all projects had planned to prepare policy briefs as a means of communicating their results to decision-makers, the project on Agricultural Best Management Practices was the only one to actually publish a policy brief over the duration of the project. Workshops with government agencies were also commonly included as a way of disseminating results, but were often delayed and not realized within the formal project period [22].

Survey respondents of all projects indicated that project outputs were predominantly targeted at the research team members themselves and academia at large. Non-academic outputs such as workshops, project reports or policy briefs mainly targeted the governmental actors, such as the Palestinian Water Authority. Private sector and civil society actors were only brought up as noteworthy target groups of project outputs in the project on rainfed agriculture in the Jenin Governorate, whereas local citizens were barely targeted by any deliverables.

3.3.2. Knowledge Dissemination Strategies

The central approach to the dissemination and application of research results in all projects was the publication of the project deliverables and their presentation at workshops or the PADUCO conferences as outlined above. Scientific articles related to research projects were almost exclusively published in a special issue of the International Journal of Global Environmental Issues that focused on water issues in Palestine [23–30]. The progress of the research projects was also presented at two PADUCO Conferences—the first one in Ramallah, Palestine, in February 2015 and the second one in The Hague, The Netherlands, in October 2015. These conferences were organized by the program management team and attracted government officials, private sector and civil society actors as well as media representatives from both countries [31]. The second PADUCO conference took place on 28 October 2015, the day before the Second Dutch-Palestinian Cooperation Forum, which targeted several sectors, including water and agriculture. Through co-organizing three sessions during the forum, PADUCO researchers were able to disseminate their results to broad audiences and discuss the challenges of and opportunities for water-related research in Palestine audiences. Individual researchers in different projects additionally indicated that meetings took place with target stakeholders in order to explore avenues of utilizing the knowledge produced in the respective research project

to solve the initially-defined societal problem. Three of the survey respondents reported ongoing collaborations with stakeholders to ensure the practical application of research results. In both cases, stakeholders involved in these application processes overlapped with the stakeholders identified as target groups or main beneficiaries of the research.

3.3.3. Follow-Up Activities and Impact Evaluation

While some survey respondents indicated further use of the project outcomes, the project on Agricultural Best Management Practices was the only one to make this follow-up explicit in the project deliverables that were available for examination. One of the project reports outlines the use of recommendations on best management practices for a farmer training program to be implemented by the Palestinian National Agricultural Research Centre, the non-academic stakeholder that was also involved in the prior research process [32]. Heun [20] also noted that most of the research work on the respective issues stopped after the completion of the projects, with little follow-up research or additional activities. Furthermore, little focus was put on the monitoring and evaluation of project impacts on the longer term. Only one survey respondent, a lead researcher on the Potential Artificial Recharge project, described a project evaluation process including governmental and civil society actors.

4. Discussion

4.1. Transdisciplinary Character of the Research Projects

All research projects included in this analysis were directly linked to existing and pressing water problems in Palestine, which were addressed within the scope of PADUCO-1. Therefore, they were suited for transdisciplinary research. However, survey results also indicate that the scientific interest in the research topic predated the interest in the societal problem for almost all projects, thereby reversing the usual transdisciplinary process of translating a societal problem into a relevant research objective [4]. Instead, it appears that a corresponding societal problem is mainly presented as a means of justifying the research project within the cooperation program that was established through PADUCO-1.

Similarly, all project proposals acknowledge the importance of systematic stakeholder involvement and feedback processes throughout the project duration. Yet in reality, most projects predominantly involved fellow researchers and government officials and engaged other stakeholder groups, such as civil society organizations, only as sources of information during data collection. Research outputs were primarily targeted at academia and governmental actors. The most inclusive approach was taken by the projects of the thematic cluster 'Water and Agricultural Production', which included significant on-the-ground work with farmers and farmer associations.

While there is thus some indication on the added-value of transdisciplinary research approaches and an understanding of the underlying benefits in development cooperation, the application of these approaches and principles within the PADUCO research projects is expandable. Bisaro et al. [33] found a similar pattern in their analysis of solution-oriented climate adaptation projects which often acknowledged the need for and planned the inclusion of multidisciplinary approaches, but failed to consistently implement them.

Reviews of transdisciplinarity and its emerging role in sustainable development research indicate a number of barriers to the successful application of transdisciplinary approaches in individual research projects, such as the lack of experienced leadership and of a coherent framing that is understood and shared by all sectors and disciplines [15,21]. These obstacles can be circumvented by shifting the focus away from individual projects towards a comprehensive transdisciplinary research agenda. While the latter implements transdisciplinary approaches in the definition of its focus, objectives and intended outcomes, individual projects might be of a different nature [15]. This model seems to fit the research projects and activities implemented within the scope of PADUCO-1, considering that the program aimed to improve "linkages between scientific research carried by

Palestinian universities and the practice on the ground” [19] (p. 6) by linking research projects with private sector involvement and national policy-making. A significant focus on transdisciplinarity was therefore included in the overall program objectives rather than in the individual project requirements. The transdisciplinary research practice at the project level can be improved by including objectives and activities that focus on the co-production of water knowledge through the collaboration of academic and non-academic stakeholders.

4.2. Dissemination and Uptake of Project Results

The critical assessment and application of project results as well as the evaluation of a project’s scientific and societal impact are key features of transdisciplinary research [4,11]. The analysis of the knowledge application stage in the PADUCO-1 research projects has shown flaws with regards to the dissemination of results to non-academic audiences and to the monitoring and evaluation of project impacts. These flaws have the potential to detract from the larger societal impact of the projects.

As the projects are part of a larger program that goes beyond the facilitation of small-scale research projects, one needs to consider whether the broader dissemination of research results and the monitoring of project impacts is indeed responsibility of the individual project, or rather within the purview of the program at large. PADUCO-1 required all projects to include communication and dissemination plans in their proposals and to list the intended deliverables. At the same time, however, the research projects comprised only one component of the research cluster within PADUCO-1. Another component was ‘Knowledge Dissemination, Awareness Raising and Annual Meetings’, which included activities such as the organization of the first and second PADUCO conferences and the exploration of private sector involvement and possible spin-offs from research projects [22]. This implies that research projects were tasked with the dissemination of their scientific results and the communication with relevant stakeholders, while the program coordination followed up on opportunities for the expansion of research projects through the involvement of private sector actors. Yet according to several internal and external assessments, the latter did not materialize [20,22]. One key reason for the unsuccessful outreach to the private sector is given in the final report of PADUCO-1 as the program’s “focus on university-to-university cooperation” [22]. This situation is also related to two contextual factors regarding the involvement of private sector in water-related research in Palestine. Firstly, due to political risks and relatively small market opportunities, Palestine is not seen as an attractive country for many Dutch water companies in general, and to be involved in research collaboration, in particular. Secondly, the involvement of private sector in research projects is not common in Palestine, particularly in the water sector, and as a result the universities and researchers have little experience in collaborating with private companies.

5. Conclusions

This paper examined six research projects within the first phase of the Palestinian–Dutch Academic Cooperation Programme on Water (PADUCO) through investigating the participation of stakeholders in three stages of the transdisciplinary research process; i.e., problem definition, knowledge production and knowledge application.

The societal problems identified and tackled in all research projects are very relevant within the Palestinian water sector, and therefore they are suitable for transdisciplinary research. The research objectives based on these problems were well defined to approach the underlying contextual factors. Research teams of each project were generally multidisciplinary and included individual non-academic members, albeit often in minor roles. Although non-academic stakeholders were included as target groups in all projects, their active involvement was indeed limited, with the sole exception of government officials, who consistently played a larger role than the non-governmental actors from private sector, civil society, or local communities. This difference between the governmental and non-governmental actors is consistent with the relatively dominant role of the governmental actors in the governance of the water sector. In terms of both the identification of research problems and

the dissemination of eventual results, projects were primarily driven by scientific interest, and less by societal impact. The communication and application of knowledge was focused on academia, with only a few follow-up activities. Monitoring and evaluation of results are crucial to ensure the societal impact of the research projects. The analysis shows a lack of monitoring and evaluation measures within the individual projects. Given the budget and time limitations of relatively small research projects, it can be argued that the longer-term impact evaluation of transdisciplinary research goes beyond the individual project level. A program-level impact evaluation can be more effective than project-level evaluation by benefiting from cross-fertilization of problem definition and knowledge dissemination activities from individual projects to reach a broader set of societal actors and interests.

Since PADUCO-1 constitutes a major water-related research program funded as part of the Dutch development cooperation policy in Palestine, the findings of this paper can be taken as practical lessons towards enhancing the added-value of transdisciplinarity in such programs. These findings also contribute to the scholarly literature as they demonstrate that starting with a transdisciplinary problem definition stage (i.e., having a transdisciplinary project scope and team composition) does not automatically translate into an active involvement of non-academic stakeholders in the knowledge production and knowledge application stages. A transdisciplinary research practice for these two stages imply the inclusion of activities and deliverables that are oriented towards the interests of non-academic stakeholders not only at the program level, but also at the project level. Regarding the involvement of societal actors in all three stages, attention should also be paid to counterbalance the pre-existing power asymmetries between different types of stakeholders and influence their potential contribution to knowledge production. Such power asymmetries mainly favor governmental organizations, who are the dominant actors of the water sector and able to participate in several research projects, whereas the non-governmental organizations and private companies often have relatively little capacity and expertise to be actively involved in research projects. The research teams should identify and engage both types of adapting the project activities and deliverables to address their specific needs and interests.

The findings presented in this paper primarily focus on the perspectives of the project teams that were formally involved in the planning and implementation of the projects. To reach a more comprehensive understanding of the transdisciplinary research processes, future research would be worthwhile in order to reveal the perspectives of the stakeholders that were not involved in the project teams, but constituted the target groups of the projects.

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Appendix A. Survey Questions

Project characteristics

- Q1 Please choose the research project you were involved in.
- Q2 What was your role within the research project?
- Q3 In which capacity were you involved in the research project?
- Q4 Which country were you located in at the time of the research project?
- Q5 Which scientific discipline(s) does your work in the project belong to?

Proposal preparation

- Q6 Which stakeholders were involved in...

the selection of the research topic?
 the choice of focus on a specific geographic area?
 the choice of focus on a specific technology?
 the identification of the research questions and/or objectives?
 the selection of research methods?

Q7 What was the motivation in selecting the specific research topic?

Q8 Please give details on the research topic selection as initiated by another actor.

Q9 Which stakeholders were involved in the writing of the project proposal itself?

Q10 Which stakeholders were identified as the target group of the research project?

Research process

Q11 How was communication within the research team organized?

Q12 How much did you interact with research members from different scientific disciplines over the course of the research project?

Q13 In your opinion, was the interaction with other researchers sufficient to reach the intended results?

Q14 Which stakeholders were involved in your work within the research as...

research team members? sources of information? sources of feedback?

Q15 How frequent were you connected with the relevant stakeholders throughout the project?

Q16 During the following steps, were there enough opportunities to reflect on insights from the research?

Data collection Data analysis Reporting of results

Q17 Were there any changes made to the research project based on these reflections? Please indicate your answer for each research step.

Q18 In any of the three research steps, were there conflicts within the research team or between the research team and other stakeholders?

Q19 Please briefly elaborate on the type of conflicts that occurred within the research team and how they were resolved.

Q20 Please briefly elaborate on the type of conflicts that occurred between the research team and other stakeholders and how they were resolved. Which stakeholders were involved?

Dissemination and impact

Q21 Which stakeholders were targeted with the different project deliverables?

Q22 How were the project results utilized in order to solve the initial research problem?

Q23 Which stakeholders were targeted in these meetings?

Q24 Which stakeholders are involved in the ongoing collaboration, aiming to ensure practical implementation?

Q25 How were the project results communicated to the scientific community?

Q26 After the project completion, were there any activities to evaluate the impact of the project?

Q27 Which stakeholders were involved in the evaluation of the project impact?

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