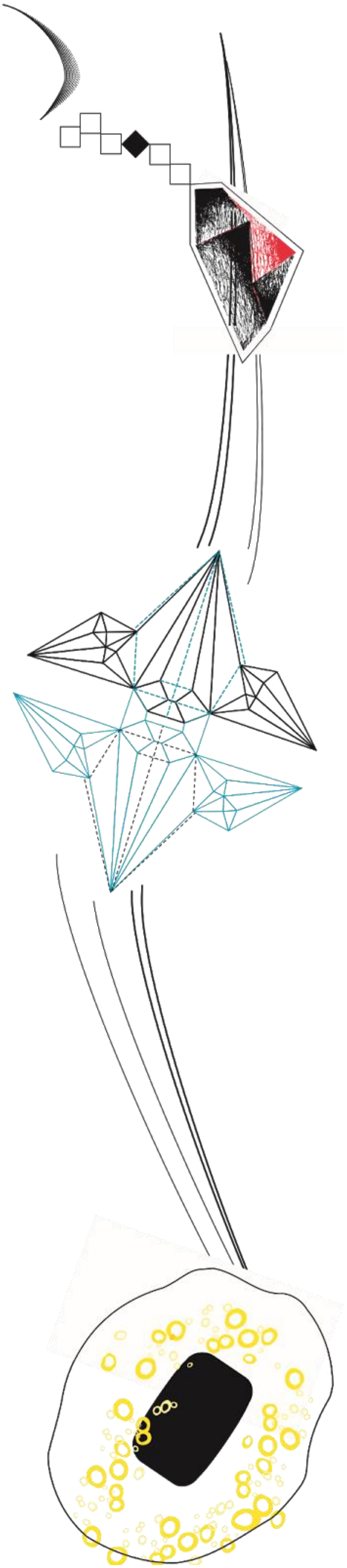


Bachelor Thesis

Farming practices and their water use in the Getas-Ngandong Forests

Towards a better understanding of stakeholders' perceptions of the effects of agroforestry and monocropping systems on water use

Rhodé Rijneveld

Supervisor Universitas Gadjah Mada	Dr. H. Marhaento
Supervisor University of Twente	Dr. Ir. M. J. Booij

Universitas Gadjah Mada

UNIVERSITY OF TWENTE.

Bachelor Thesis

Farming practices and their water use in the Getas-Ngandong Forests

Towards a better understanding of stakeholders' perceptions of the effects of agroforestry and monocropping systems on water use

Submitted by:
Rhodé Rijneveld
Civil Engineering

Supervisor University of Twente:
Dr. Ir. M. J. Booij

Supervisor Universitas Gadjah Mada:
Dr. H. Marhaento

Final version
12-04-2019

PREFACE

In front of you lies the outcome of the bachelor thesis project that is part of the civil engineering bachelor of University of Twente. Almost one year ago, the preparations for this project started. I wanted to do a project related to water management in a non-European country to experience working in a different culture. I combined this project with an internship at the Watershed Office in Solo, which was part of the minor 'Crossing Borders'. This combination increased the flexibility for the planning of the field study for the thesis project.

This bachelor thesis would not have been possible without the help of many people. I went to Indonesia alone, but there were so many people who helped me with administrative issues to practical and technical issues. I am very thankful for everyone who helped me with some part of my stay in Indonesia.

Special thanks to Mbak Judith, for helping me with the visa procedures during my first week in Jakarta. Special thanks to Rian and Azis for assisting me during the field study in Getas. Special thanks to Dr. H. Marhaento for supervising me at the Gadjah Mada University, for giving feedback at several occasions, and for organising the field study so well. Special thanks to Dr. Ir. M. J. Booij for supervising me at University of Twente. I also want to thank all my friends in Yogyakarta who supported me and showed me around in their beautiful country.

Terima Kasih!

29th March 2019, Yogyakarta

SUMMARY

In 2017 the government of Indonesia entrusted the Getas-Ngandong forests (also referred to as KHDTK), located on Java, Indonesia, to be managed by UGM from 2017 to 2037. The area is utilised for the planting of teak and for farming. Local farmers use both agroforestry and monocropping systems to cultivate their crops. However, in the current situation, they are threatened by water-related problems, such as unreliable water availability, droughts, and floods. Consequently, it is crucial to correctly manage the water use of farming practices to maximise their productivity and efficiency. Because stakeholders' involvement is needed, considering their perceptions is relevant to planning actions for the management and development of KHDTK. This project describes the current situation of the farming practices and it then identifies stakeholder perceptions on the water issue to contribute to the management and development of KHDTK.

The study area of this thesis project consists of the village area of Getas and Pitu covering 32% of the KHDTK area. The farming communities in both Getas and Pitu have a high dependency on state forests. In Getas, most agroforestry systems are applied in state forests. However, Pitu depends less on state forests and applies agroforestry systems in both state forests and community-owned forests. In both Getas and Pitu maize, sugarcane, and rice are the most grown crops in agroforestry systems and monocropping systems. Furthermore, farmers in Getas and Pitu generally have a rainfed agriculture. Thus, during the dry season or periods of drought, there is often no farming activity, unless farmers use irrigation systems. Consequently, in the rainy season the attitude to water availability is positive and in the dry season primarily negative. However, the presence of springs provides opportunities to use irrigation systems in both areas, but farmers in Pitu can also irrigate from the Bengawan Solo river. This partly accounts for the more positive attitude of Pitu farmers compared to Getas farmers to general water availability. Additionally, crops such as maize and sugarcane are generally cultivated on hilly areas, so floods do not influence these farming lands. Farmers tend to plant wet rice fields in monocropping systems in valleys or near flood sensitive rivers while dry rice fields are often cultivated in agroforestry systems. Consequently, lands with monocropping systems are situated closer to a river and thus farmers with monocropping systems have a more positive attitude towards water availability than farmers with agroforestry systems.

The key stakeholders that are related to the water issues in the study area are the village communities of Getas and Pitu, the local governments, the previous and current managers of the area, and the watershed office. Among all stakeholders there is consensus on some hydrological benefits of agroforestry systems, such as increased regional water availability, and reduced risk of floods and surface runoff. Also, there is a general confidence that trees and crops do not compete for available soil water. Beyond this consensus, three perceptions are identified that express distinct attitudes regarding the water use of farming practices. The first perception strongly states that monocropping systems have a higher water use than agroforestry systems, while the second perception states the opposite. The third perception is reluctant to assign the extent of water use to a specific system, and states that factors such as species and planting pattern define water use. Furthermore, the first and third perception are confident that agroforestry systems are a good application for soil and water conservation, yet the second perception reveals a more sceptical attitude. Each stakeholder group represents two or even all three perceptions. Thus, within and between stakeholder groups there are contradicting beliefs of the effects of agroforestry and monocropping systems on water use.

As for the management of the area, it is not possible to address the stakeholder groups in one specific manner, since each group represents several perceptions. Within stakeholder groups there are different knowledge levels and stakeholders believe in contradicting benefits or disadvantages of farming practices. Therefore, it is important to carefully identify those beliefs that are true and those that are based on myths. Then, for the development of the area the water use of agroforestry and monocropping systems should be quantified and the optimal combination of crops and trees in the Getas and Pitu should be explored. Furthermore, UGM favours agroforestry systems and the farming communities of Getas and Pitu both recognize some benefits of agroforestry systems. This could be used as a basis to encourage the communities to apply more agroforestry systems and thus preventing

them from changing forest areas into monoculture areas. However, it should be very clear to the farming communities why the conservative benefits of agroforestry systems are surpassing the disadvantages of a higher water use and subsequent lower crop yield.

KHDTK forest management aims to maximise the productivity and efficiency of the forest and forest-farming systems to increase community welfare. UGM will achieve this by including research activities and participation of all stakeholders in the management and development of KHDTK. In the future, the specific (hydrological) claims and functions of forests and monocropping and agroforestry practices should be investigated thoroughly. This should be done in the Getas and Pitu area, but also in other KHDTK areas. Next, this study focuses on the water availability in the study area and water use of the farming practices, but other studies could be conducted focusing on other elements. For example, the influence of tree species or soil conditions on the productivity and efficiency of the forest and forest-farming systems could be investigated. Furthermore, the identified perceptions reveal a consensus among stakeholders, but also pinpoint divergent attitudes. These can guide awareness-raising campaigns and assist in the process of including stakeholders in the management and development of the area.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

Term	Explanation
BPDASHL Solo	Balai Pengelolaan Daerah Aliran Sungai dan Hutan Lindung Solo
FAO	Food and Agricultural Organisation
FGD	Focus group discussion
GIS	Geographic Information System
HPD	Hutan Pangkuan Desa
KHDTK	Kawasan Hutan Dengan Tujuan Khusus
LMDH	Lembaga Masyarakat Desa Hutan
PCA	Principal Component Analysis
PHBM	Pengelolaan Sumber daya Hutan Bersama Masyarakat
RPH	Resort Pemangkuan Hutan
UGM	Universitas Gadjah Mada
USDA	United States Department of Agriculture

1. INTRODUCTION

This introductory chapter presents the problem context in section 1.1. Section 1.2 then presents the state of the art and section 1.3 the research aim and the research questions of this thesis project. Lastly, sub chapter 1.4 gives an overview of the structure of the report.

1.1. Problem context

In 2017 the government of Indonesia entrusted the Getas-Ngandong forests, located on Java, Indonesia, to be managed by Universitas Gadjah Mada (UGM) from 2017 to 2037. The Getas-Ngandong forest, also referred to as KHDTK (forest area with special objectives) has an area of roughly 11,000 hectares; see Figure 1. It is located in two districts and two provinces, namely Blora District, Central Java and Ngawi District, East Java. For an explanation of the administrative regions of Indonesia, see Appendix A. The KHDTK area is utilised for the planting of teak and for farming. Local farmers use both agroforestry systems and monocropping systems to cultivate their crops. However, in the current situation, they are threatened by water-related problems, such as unreliable water availability, droughts, and floods. Consequently, it is crucial to correctly manage the farming practices and their water use to maximise their productivity and efficiency.

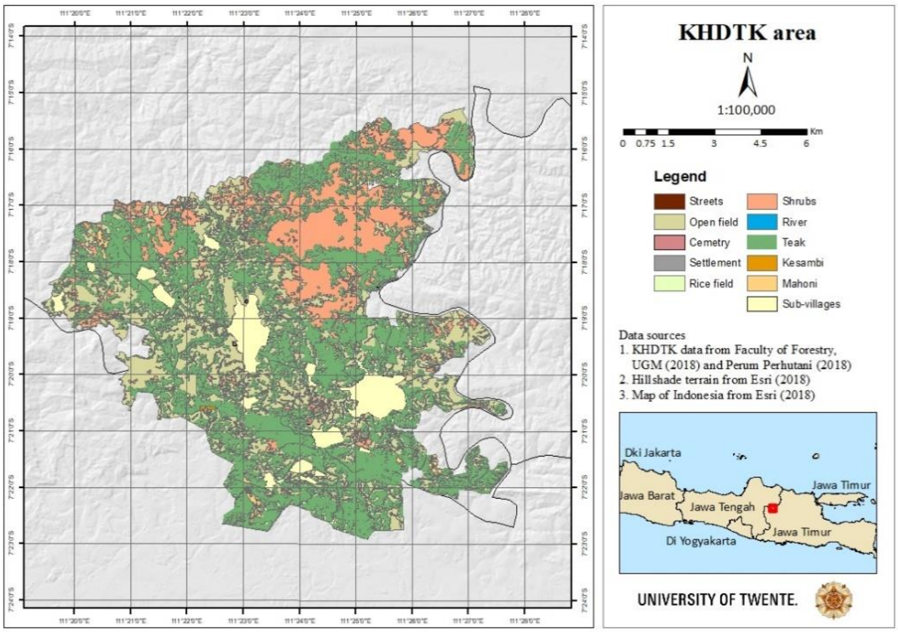


Figure 1: The KHDTK area.

1.2. State of the art

The topic of this thesis project covers the fields of (tropical) forestry, hydrology, and agriculture. To describe the state of all these fields with its current positions and recent (scientific) developments would be an immense study. Therefore, only the overlapping topics will be explored. Firstly, the hydrological aspects of forests will be explored followed by the hydrological aspects of farming practices.

Hydrological aspects of tropical forests

According to the Food and Agricultural Organization (FAO), 53% of Indonesia's land cover is forested and roughly 50% of these forests are classified as primary forests (FAO, 2015). However, the deforestation rate is significant, for 20% of Indonesia's forest cover was lost between 1990 and 2010 (Butler, 2010). There is a widespread belief according to Bruijnzeel that deforestation is the main cause for floods, decline of rainfall and deterioration of the soil (Bruijnzeel, 2004). However, the potentially beneficial relationship between forest cover and water yield is strongly questioned and under constant debate (Calder, 1998; Ellison, Futter, & Bishop, 2012). In general, two perspectives, both with the fundamental assertion that trees use water, on forests and its hydrological aspects can be distinguished.

One view, which is sometimes referred to as the 'supply-side' of the debate, suggests that increasing forest cover raises the water yield and improves water availability at the regional and/or global scale. This is because this perspective of the role of forests is that forests act as a sponge. The tree roots, forest litter, and soil act as a sponge and some even claim that the tree roots release the water, that was soaked in during the wet season, evenly during the dry season. This sponge effect will maintain the water supplies during the year (Bruijnzeel, 2004; Ellison et al., 2012).

The other view is presented by the 'demand-side' of the debate, regarding forests as consumers of available water and competitors for other water uses, such as agriculture. A claim in this perspective is that roots should be considered as pumps rather than sponges and that roots do not release water during the dry season but instead remove it from the soil for the trees to grow (Hamilton, 1983).

According to Bruijnzeel, nowadays there seems to be a growing tendency to emphasise on the more negative aspects of forests such as their higher water use and their inability to prevent extreme floods rather than their protective values such as enhanced water quality, moderation of most peak flows and carbon sequestration (Bruijnzeel, 2004).

The beforementioned views are part of the outcomes of extensive research that has taken place in the past half century to understand the nature and dynamics of hydrological processes in tropical catchments. Currently, a solid body of scientific information for interpreting the relationships between water and forests in tropical regions is available. However, there are still the two perspectives on the role of forests that sometimes contradict each other. Some even attribute debate over the outcome of increased forest cover on water yield to the gap between public perceptions and scientific knowledge (Calder, 1998; Gilmour, 2014).

Agriculture and its hydrological aspects

The FAO has predicted that the food production must increase by 70% by 2050 to meet the needs of a growing world population (FAO, 2009). This will cause several problems, one of them being an intensification of existing agricultural practices (Smith, Pearce, & Wolfe, 2013). More than 30% of the land cover of Indonesia is defined as agricultural land, thus providing many opportunities for optimising its agricultural practices (Central Intelligence Agency, 2018).

The agricultural practices distinguished in this thesis project are agroforestry systems and monocropping systems. Agroforestry is defined as a land-use system in which woody perennials (trees, shrubs, etc.) are grown in association with agricultural crops, pastures, or livestock, in a spatial arrangement, a rotation or both (Nair, 1993). Monocropping consists of cultivating one type of crop on the same land. See Figure 2 for a visualisation of these systems.

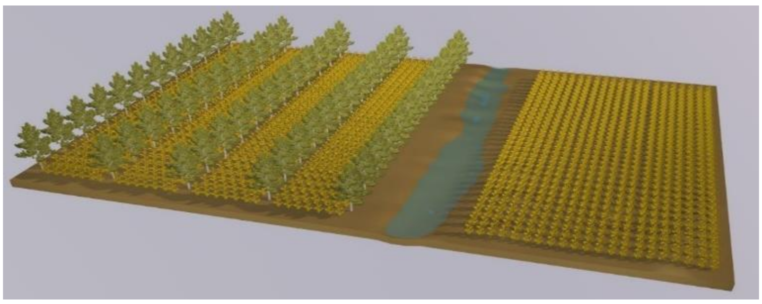


Figure 2: An agroforestry system on the left and a monocropping system on the right (Yuwono et al., 2018).

Agroforestry systems versus monocropping

A central hypothesis in agroforestry systems is that its productivity is higher compared to monocropping systems since the trees acquire resources that the crops alone would not (Cannell, Van Noordwijk, & Ong, 1996). In addition, agroforestry systems are believed to provide many ecosystem services and environmental benefits, such as the regulation of soil, air and water quality and carbon sequestration (Jose, 2009). Agroforestry is an acceptable practice in sustaining the hydrological cycle and providing a reliable tool for soil and water conservation in a watershed (Idris & Mahrup, 2017). However, the complex relationship between soil water content, rainfall, water uptake by plants and evapotranspiration throughout the seasons makes it extremely difficult to fully understand water dynamics within an agroforestry system. Some hydrological components of agroforestry systems are:

- Through water tapping and prevention of nutrient leaching, trees help recover nutrient, conserve soil moisture and improve soil organic matter (Mbow et al., 2014).
- The addition of trees to a monocropping system may increase the water-use of the system directly, by increased rainfall utilization compared to annual cropping systems (Jackson, Wallace, & Ong, 2000; Mbow et al., 2014).
- Increased plant water use can also occur indirectly through a modification of the crop micro-climate (due to shade effects for example) so that less water is lost through soil evaporation, and hence more is available for tree and crop transpiration (Jackson et al., 2000; Smith et al., 2013).
- River bank buffers and other agroforestry systems can help reduce runoff and increase infiltration (Smith et al., 2013).
- Also, with the prediction of an increase in natural hazards and extreme events (such as flooding and droughts) due to climate change, increasing the number of trees in a landscape can reduce the impact on the farming systems since the trees act as buffers. In agroforestry systems, the surface runoff is reduced and there is an increased infiltration and soil water holding capacity. Therefore, the risk of flash flooding after periods of heavy rainfall is reduced (Smith et al., 2013).

Thus, in agroforestry systems the water-use of the overall system will increase. Next, the competition between trees and crops for available soil water must be minimised since water availability is a main factor of determining the success of an agroforestry system. Consequently, this leads to compromises such as reduced crop yield compared to monocropping systems, if the trees are allowed to grow large enough to utilise soil water otherwise lost through drainage (Jackson et al., 2000). However, this complementarity between trees and annual crops makes soil resource utilization more efficient than in monocropping systems (Mbow et al., 2014).

In the last few decades, extensive research has been done in the fields of forestry, hydrology, and agriculture. There is a solid scientific body for interpreting the hydrological role of tropical forests, although the scientific community is divided in its perceptions of the hydrological function of trees (Gilmour, 2014). In addition, many point out that additional evidence for the hydrological claims and products of agroforestry systems should be found to affirm these claims (Jackson et al., 2000; Jose, 2009; Mbow et al., 2014). This indicates that, although many studies have been done in the fields of forestry, hydrology and agriculture, there is a general need for further research in the future to specific claims and functions.

The KHDTK area provides opportunities for this type of research. The Faculty of Forestry (UGM) will manage this area and it aims to build the forests into a model and example for forest management (Universitas Gadjah Mada, 2017b). It will achieve this by adopting a social forestry strategy. All management activities will be directed towards educational and training activities as well as forestry research and development to improve the welfare of forest village communities. Furthermore, it also includes developing the forest area by involving various stakeholders for the benefit of community empowerment and management planning (InfoBlora, 2017; Yuwono et al., 2018). In addition, the Dean of the Faculty of Forestry emphasized on the involvement of various stakeholders to receive the support of all (Universitas Gadjah Mada, 2017a). Literature also acknowledges the need of understanding perceptions of stakeholders as a prerequisite to successful development planning (Nair, 1993). However, convincing evidence that this understanding has been attained is often lacking. It is frequently assumed that government officials and technical experts who advise these officials understand the population they govern. Others further confirm the need to understand and incorporate the local communities' perceptions of various issues in forest management regimes to align the interests of all stakeholders (Guthiga, 2008; Hutton & Leader-Williams, 2003). Thus, involving stakeholders in forest management decisions is crucial to the success of these programmes (Silvano, Udvardy, Ceroni, & Farley, 2005).

1.3. Objective and research question

KHDTK forest management aims to maximise the productivity and efficiency of the forest and forest-farming systems to increase community welfare. This objective will be achieved by including research activities and participation of all stakeholders in the management and development of KHDTK. In KHDTK, local farmers use both agroforestry systems and monocropping systems, but they are threatened by water-related problems. This thesis project will describe the current situation of the farming practices and the water availability in the farming lands. It will then explore stakeholder perceptions on the water issue to contribute to the management and development of KHDTK. Thus, the research aim is:

> *Identify farming practices in the Getas-Ngandong forests and compare the perceptions of key stakeholders on the effects of agroforestry and monocropping systems on the water use in the farming lands to contribute to the development and management of the area*

The research questions that will contribute to the research aim are:

1. How can the farming practices and the water availability in the study area be described?
   1.1. How are the farming lands currently used?
   1.2. How can the water availability in the farming lands be described?
2. What are the perceptions of the key stakeholders on the effects of different farming practices on the water use in the farming lands?
   2.1. Who are the key stakeholders?
   2.2. To what extent are the varying farming practices different in their water use according to the stakeholders?
   2.3. To what extent are the perceptions represented within stakeholder groups?
3. What are considerations for future management and development of the study area?
   3.1. What is the common basis?
   3.2. What are focus points?

1.4. Thesis structure

Chapter 2,3, and 4 present the findings of the research questions. Each chapter has a similar structure with an introduction, methodology, presentation of the findings, discussion, and conclusion. Chapter 2 describes the study area, farming practices, and water availability. Then, chapter 3 introduces the key stakeholders, and identifies and compares their perceptions. Following, chapter 4 presents considerations for future management and development. Chapter 5 then gives a conclusion and recommendations. The appendices give additional explanations and provide additional data.

2. FARMING PRACTICES AND WATER AVAILABILITY

This chapter gives an answer to the first research question: '*How can the farming practices and the water availability in the study area be described?'*. Section 2.1 first describes the methodology. Section 2.2 then shows several characteristics of the study area, including climate, land cover and population characteristics. Next, section 2.3 explores the current use of the farming lands through an analysis of different types of land ownership and farming practices. Then, section 2.4 describes the water availability in the farming lands. Following, section 2.5 and 2.6 give a discussion and conclusion.

2.1. Methodology

Firstly, general characteristics of the study area were obtained by studying the management report of the KHDTK area (Yuwono et al., 2018). Also, current spatial data of the KHDTK area was analysed in GIS-software (Geographic Information System) for the specific study area. Next, a sampling design was made to identify the type of crops, the farming practices, and the water availability in the study area. Based on resource and time constraints, the maximum number of samples was chosen to be 12, of which 6 sites represented agroforestry systems and 6 sites represented monocropping systems. A local counsellor determined these 12 locations, ensuring that the samples were representative for the study area. At each location observations of the crops and farming practice were done, and the farmer was interviewed on the water availability in the farming land. Farmers were questioned on their attitudes towards water availability and issues such as the source of water for the farming lands and the occurrence of floods and droughts. See Appendix B for the interview preparations, procedures, and the format. The data was then processed and analysed using Excel.

2.2. The study area

The KHDTK area is located in two districts and two provinces, namely Blora District, Central Java (roughly 80%) and Ngawi District, East Java (roughly 20%). The area contains 15 villages; 9 villages are situated in the Kredenan, Randublatung and Jati subdistricts in the Blora district and 6 villages are situated in the Pitu subdistrict in the Ngawi district. The study area of this thesis project consists of the village area of Getas and Pitu (see Figure 3). These villages were chosen, because the farmers cultivate their crops in different ways and the two villages are located in two different districts. Table 1 shows an overview of the administrative regions of these villages. The village areas are defined by UGM management boundaries. Consequently, they differ from the official village areas. See Appendix A for an explanation and visualisation of these different types of boundaries.

Table 1: Districts and size of the two villages.

Village	Sub-district	District	Province	Area (ha)	Percentage of KHDTK
Getas	Kradenan	Blora	Central Java	2265	21%
Pitu	Pitu	Ngawi	East Java	1214	11%

Climate and soil type

Most of the UGM KHDTK area has 2000-2400 mm of rainfall per year in the D (moderate) climate category based on Schmidt-Fergusson (Yuwono et al., 2018). This climate classification method is based on the ratio of dry months (<60 mm) to wet months (>100 mm), expressed as a percentage. Category D has a ratio of 60 – 100 %. The rainy season lasts from November to March and the dry season lasts from April to October.

According to the USDA (United States Department of Agriculture) classification, the KHDTK area is dominated by Alfisol soil types (Yuwono et al., 2018). These soil types contain aluminium and iron and they are mostly found under forest stands. Alfisol is suitable for crop cultivation, since the soil is generally fertile and productive because of the high concentration of nutrients. As Figure 4 shows, Getas and Pitu primarily consist of clay and sand deposits, but the northern part of Getas consists of limestone and marl.

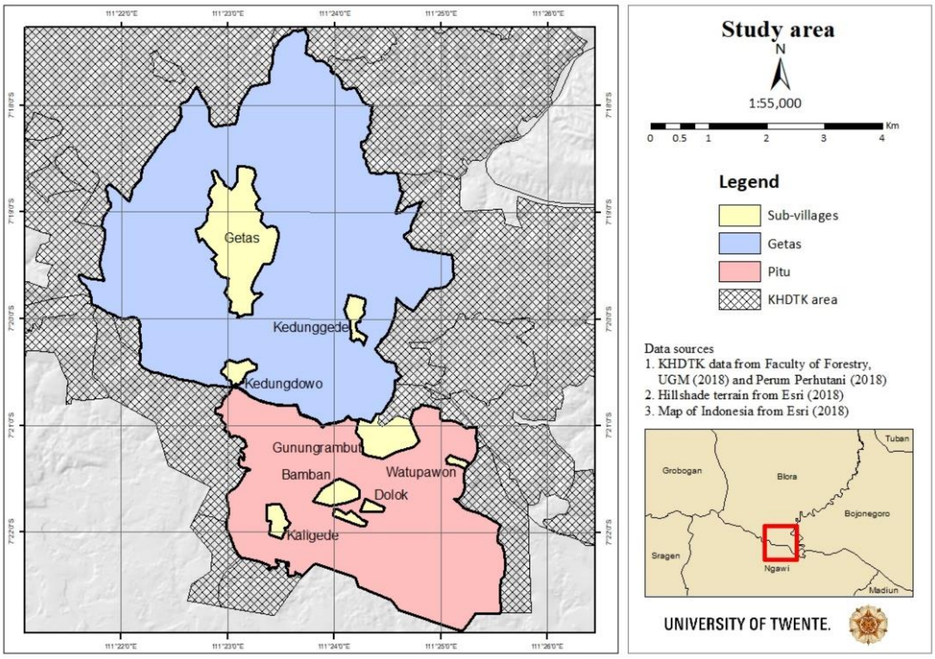


Figure 3: Location of the study area

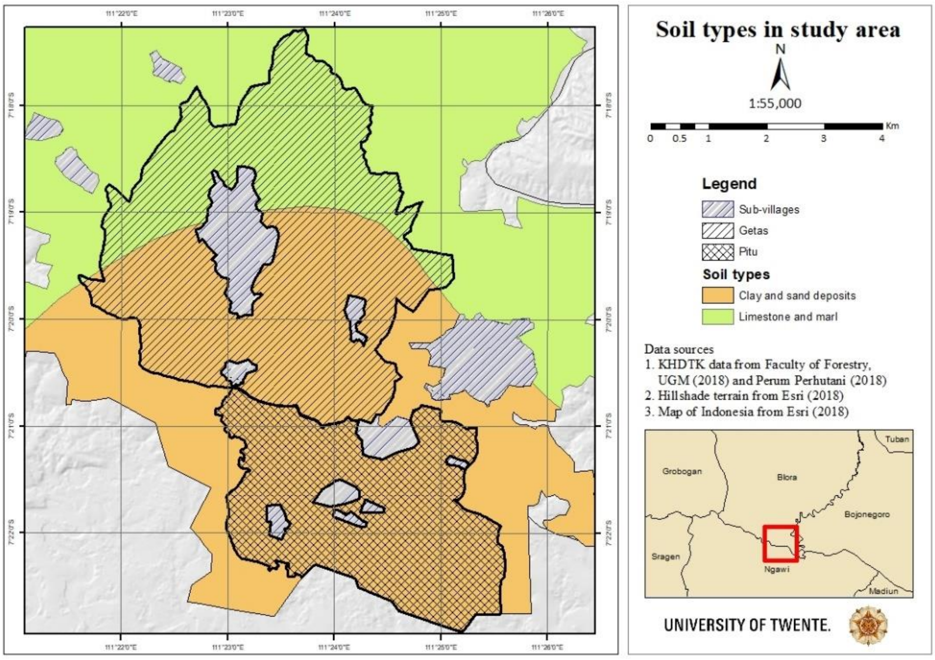


Figure 4: Soil types in the study area.

Land cover

The land cover map of the KHDTK area was made by the faculty of forestry through spatial analysis from a recent aerial photo. Figure 5 shows that in both Getas and Pitu there is much teak forest, although in Pitu there is more teak. Thus, in the study area, there is much potential for agroforestry. Moreover, Getas has significantly more open fields and shrubs compared to Pitu. Figure 4 and Figure 5 show that the shrubs in Getas are mostly found on a limestone and marl soil.

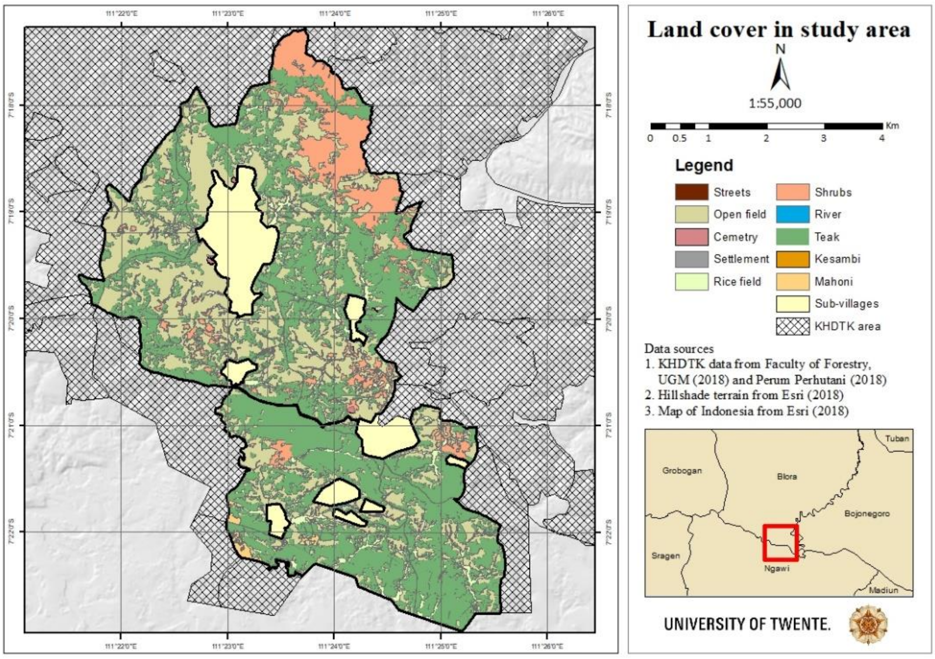


Figure 5: Land cover in the study area.

The population

Both Getas and Pitu have a population of almost 5000 people (as measured in 2015). The livelihoods of forest village communities are mostly farmers and farm laborers (83%), who cultivate crops or have livestock. Other livelihoods are civil servants, private employees, entrepreneurs, and non-agricultural workers. 99% of the population is Muslim (Yuwono et al., 2018).

2.3. The farming practices

The current use of the farming lands was explored through a study of the management report and a field study. Firstly, this chapter describes the land ownership in both villages. Following, it shows the sampling locations in the study. The farming practices are described through an analysis of the sampled locations and through additional observations in the study area.

Land ownership

Farmers in Getas and Pitu cultivate crops in both agroforestry and monocropping systems. The farming practices in the KHDTK area are done on owned-land and state forest land. With a relatively small owned-land area and limited biophysical conditions of the lands, in general the community cannot fulfil their daily needs just by managing their own land. The community has thus expanded the cultivation of agricultural crops on state forest land. In Getas, the community owned land is 0.15 ha per person and the state forest is 0.69 ha per person; for Pitu this is 0.15 ha per person and 1.1 ha per person. In addition, a population pressure analysis has shown that the land owned by the village communities in KHDTK is unable to meet the living needs of people who have a livelihood as farmer. This analysis combines data of the (farming) population, cultivated land areas, and open field areas to calculate the extent to which the farming lands meet the needs of the population which is expressed as the 'population pressure'. In Getas, the population pressure is 6.8 and in Pitu it is 3.3; a pressure higher than 1 already indicates the inability of community owned lands to meet the needs of the people. Hence, community dependence on forest land is very high. Consequently, a population pressure analysis of community owned lands combined with the village's forest areas gives a much lower and sufficient pressure of 0.34 for Getas and 0.83 for Pitu (Yuwono et al., 2018). The village's forest areas are referred to as 'Hutan Pangkuan Desa' (HPD) which translates to 'state forest within village area'.

Agroforestry and monocropping systems

A sampling design was made to identify the type of crops, the farming practices and water use in the area. Based on resource and time constraints, 12 sample locations were chosen throughout the area. In both Getas and Pitu, 3 locations represent an agroforestry system and 3 locations represent a monocropping system. Furthermore, additional observations were done to provide deeper insights. Figure 6 shows an overview of the sample locations in the area.

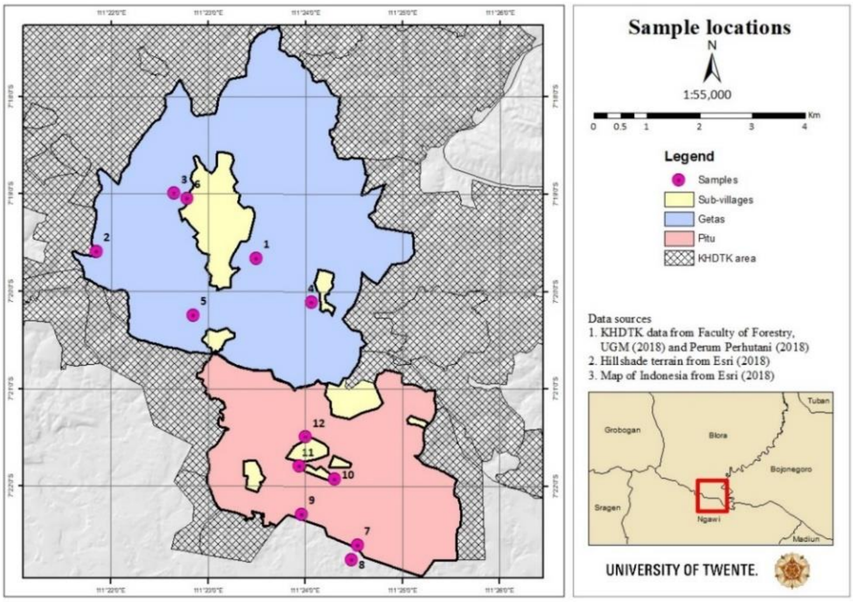


Figure 6: Sample locations in the study area.

The locations were chosen by a local counsellor and this ensures a variety of locations, even if the samples are not spatially balanced. One of the sample locations is situated outside the UGM management borders, although it is inside the official village area. The area is similar to the area in the UGM management area, so the sample will be acknowledged in the analysis of the study area.

Table 2 presents an overview of the farming practices, the crops, and the age of the crops.

Table 2: An overview of the data obtained at the sample locations.

Sample	Location	Farming practice	Type of crop	Age of crop (months)
1	Getas	Agroforestry	Dry rice field	3.5
2	Getas	Agroforestry	Maize	2.3
3	Getas	Agroforestry	Maize	4
4	Getas	Monocropping	Wet rice field	0
5	Getas	Monocropping	Sugercane	2
6	Getas	Monocropping	Maize	4
7	Pitu	Agroforestry	Dry rice field	2
8	Pitu	Agroforestry	Maize	3.6
9	Pitu	Agroforestry	Maize	2
10	Pitu	Monocropping	Maize	3.5
11	Pitu	Monocropping	Wet rice field	3.2
12	Pitu	Monocropping	Maize	3

The sample study clearly indicates that maize, sugarcane, and rice are the most grown crops in both areas, although additional observations show that in Pitu, also vegetables such as cucumbers, tomatoes and pepper are grown. Next, the sample study and additional observations show that in both villages wet rice fields are mostly cultivated in monocropping systems, but dry rice fields are grown in agroforestry systems. Additional observations reveal that in Getas, agroforestry systems generally exist in state forests. However, in Pitu half of the agroforestry systems are in state forests and the other half in community forests. Moreover, the distance as the crow flies to the nearest river is determined for the sample locations; Figure 7 presents these findings.

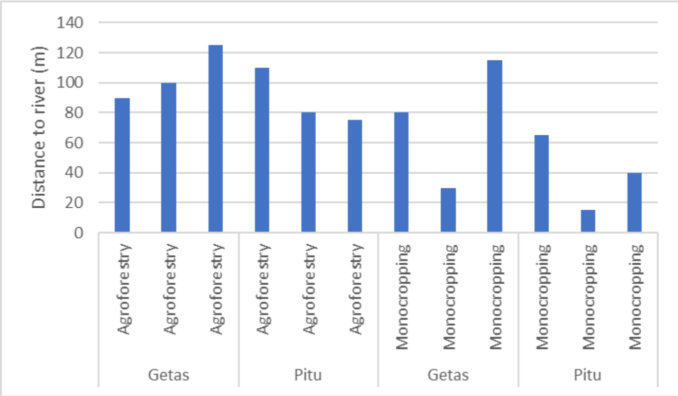


Figure 7: Distance to the nearest river.

Generally, farming lands with monocropping systems are situated closer to a river than farming lands with agroforestry systems. Also, lands with agroforestry systems in Pitu are closer to a river than agroforestry lands in Getas, and this is similar for the monocropping systems. Although these rivers exist in the rainy season, they may be dry in the dry season depending on the presence of nearby springs or bigger rivers.

2.4. Water availability in the farming lands

This section aims to describe the water availability in the farming lands in Getas and Pitu. Interviews were done with farmers in Getas and Pitu to obtain a first impression of the water availability and additional observations provided a deeper insight.

Interview results

In both villages 6 interviews were done with farmers. For the locations of their farming lands, see the sample locations in Figure 6. The interview explores practices of water use and attitudes towards water availability; see Appendix B for the interview format. The results of the interviews can be divided into three sub-topics:

- Attitudes towards water availability
- Location of water resources for the farming lands
- Occurrence of floods and droughts

Each sub-topic will be analysed from two perspectives, namely by the farmers in Getas or Pitu and the farmers with agroforestry or monocropping systems.

Attitudes towards water availability

The attitudes towards water availability for the farming lands were investigated for general availability and availability during the rainy and dry season. See Figure 8 for an overview of these attitudes.

The attitudes for general water availability in both perspectives are divided from slightly negative to quite positive, but farmers in Getas hold a more negative attitude than farmers in Pitu. This suggests that, generally, less water is available for the farming lands in Getas.

For the water availability in the rainy season, the farmers are positive in both villages and for both farming systems. However, Getas farmers are more explicitly positive than the Pitu farmers and farmers with agroforestry systems hold slightly more negative attitudes towards the water availability in the rainy season.

The attitudes for the dry season are similar in both perspectives; extremely negative, although farmers with agroforestry systems are the most negative. One of the reasons for this is that some monocropping systems were situated close to a spring, making irrigation possible.

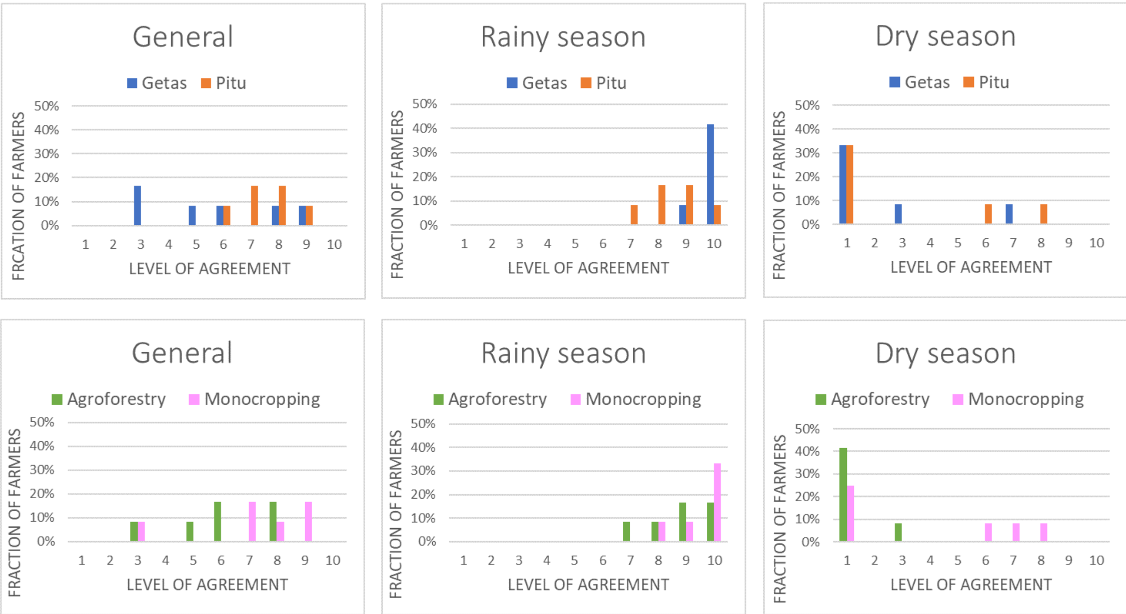


Figure 8: An overview of the attitudes towards water availability categorized by farmers in the same village and farmers with the same farming system (1= poor availability, 10 = good availability).

Location of water resources for the farming lands

Secondly, the location of water resources for the farming lands was explored for the rainy season, dry season, and periods of drought. Periods of drought are defined as unexpected dryer periods apart from the dry season. Farmers using a river use surface water, while farmers applying irrigation systems use ground water. See Figure 9 for an overview of these results. Figure 9 illustrates that both perspectives are quite similar in how they obtain water for the farming lands. During the rainy season, farmers from both villages and with both farming practices are very dependent on rainfall. In the dry season, generally, farmers are still dependent on rainfall and therefore there is often no farming. However, some farmers with monocropping systems are less vulnerable to the dry season since they can use irrigation. During periods of drought, only farmers with irrigation systems can continue to grow crops.

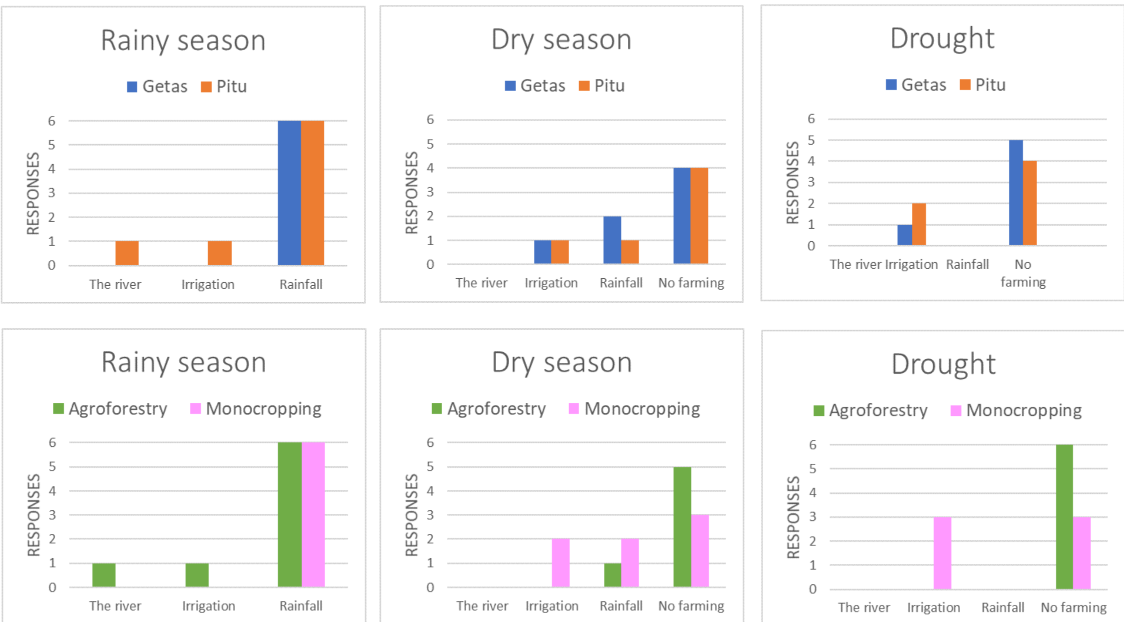


Figure 9: An overview of locations where farmers obtain their water for the farming lands categorized by farmers in the same village and farmers with the same farming system.

Occurrence of floods and droughts

See Figure 10 for an overview of the occurrence of floods and droughts in the farming lands.

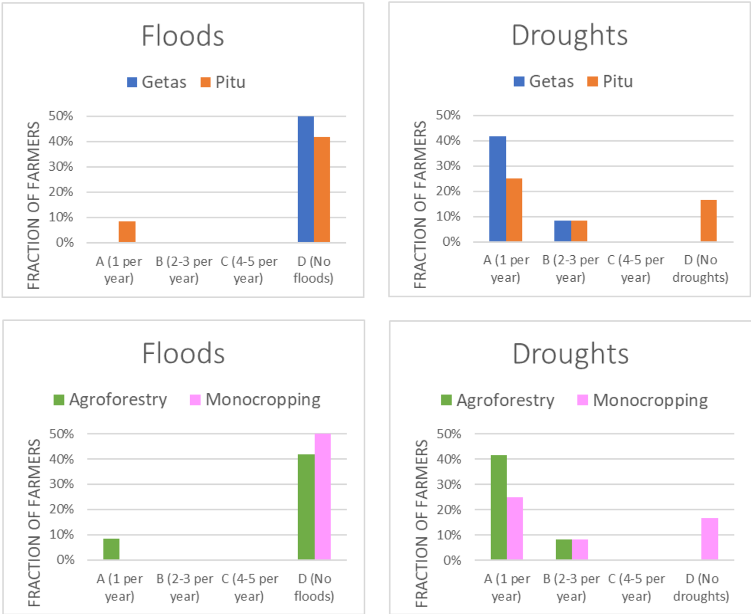


Figure 10: An overview of the occurrence of floods and droughts categorized by farmers in the same village and farmers with the same farming system.

In both villages and for both farming systems, there are generally no floods, and droughts occur once a year (which generally refers to the dry season). For farmers that do grow crops during droughts, farming becomes more expensive because of water transportation costs.

Additional observations

Additional observations show that both areas generally have a rainfed agriculture. However, Pitu farmers can also use irrigation from the Bengawan Solo river. Getas also has some tributaries from this river in its area, but they tend to be small and unreliable for farming since they are empty in the dry season and flooding in the rainy season. Both areas are hilly, and farmers tend to grow crops such as maize and sugarcane on the hills so that they are not influenced by floods. Wet rice fields are planted in valleys or near rivers that are more sensitive to floods. Furthermore, some rivers dry out in the dry season, depending on the presence of a spring in the vicinity. In Getas, there are roughly 5 springs, although only 3 do not dry out during the dry season and not all are available for the farming lands. In Pitu there are roughly 2 springs that do not dry out during the dry season.

2.5. Discussion

The characteristics of the study area are described through the management report of KHDTK and the created maps. The management report is recently written, and the shape files are based on recent data. Thus, these data sources are a reliable source of information, which ensures a solid description of the area. Next, the findings presented in chapter 4.2 and 4.3 are mostly based on a field study. The sample size of this study is influenced by time and resource constraints, but these constraints more often determine sample size in land-use studies (Nusser & Klaas, 2003; Stein & Ettema, 2003). Then, generally, for a representative sample a spatially balanced design is often favoured to ensure spatial coverage of the entire survey area. However, in this study, a local counsellor chose the locations, since he could ensure a variety of farming lands in the study area. Nevertheless, additional observations were done to gain further insights of the study area.

2.6. Conclusion

This chapter aims to describe the farming practices and the water availability in the study area. The current use of the farming lands is described through different ownership types and different types of farming practices. The Getas farming community has a high dependency on state forests. Thus, in Getas, most agroforestry systems are applied in state forests, while in Pitu agroforestry systems are applied in both state forests and community-owned forests. In both Getas and Pitu maize, sugarcane, and rice are the most grown crops in both agroforestry systems and monocropping systems. Furthermore, farmers in Getas and Pitu generally have a rainfed agriculture. Thus, during the dry season or periods of drought, there is often no farming activity, unless farmers use irrigation systems. Consequently, in the rainy season the attitude to water availability is positive and in the dry season primarily negative. However, the presence of springs provides opportunities to use irrigation systems in both areas, but farmers in Pitu can also irrigate from the Bengawan Solo river. This partly accounts for the more positive attitude of Pitu farmers compared to Getas farmers to general water availability. Additionally, crops such as maize and sugarcane are generally cultivated on hilly areas, so floods do not influence these farming lands. Farmers tend to plant wet rice fields in monocropping systems in valleys or near flood sensitive rivers while dry rice fields are often cultivated in agroforestry systems. Consequently, lands with monocropping systems are situated closer to a river and thus farmers with monocropping systems have a more positive attitude towards water availability than farmers with agroforestry systems.

3. STAKEHOLDERS' PERCEPTIONS

This chapter presents the findings of the second research question: '*What are the perceptions of the key stakeholders on the effects of different farming practices on the water use in the farming lands?*' First, section 3.1 presents the methodology. Section 3.2 then identifies the key stakeholders and their roles. Next, section 3.3 presents the perceptions of the stakeholders. Following, section 3.4 investigates the distribution of the perceptions within and between stakeholder groups. Lastly, sections 3.5 and 3.6 give a discussion and conclusion.

3.1. Methodology

Q methodology (hereafter referred to as Q) was applied to identify and analyse the stakeholders' perceptions. Q is a clearly structured, systematic and increasingly-used methodology designed specifically to identify typologies of perceptions (Zabala, 2014). See Appendix C for an elaborate clarification of the choice of the method, the background of Q, and the use of Q in the fields of forestry, agriculture, and hydrology. See Figure 11 for an overview of the research process of Q.

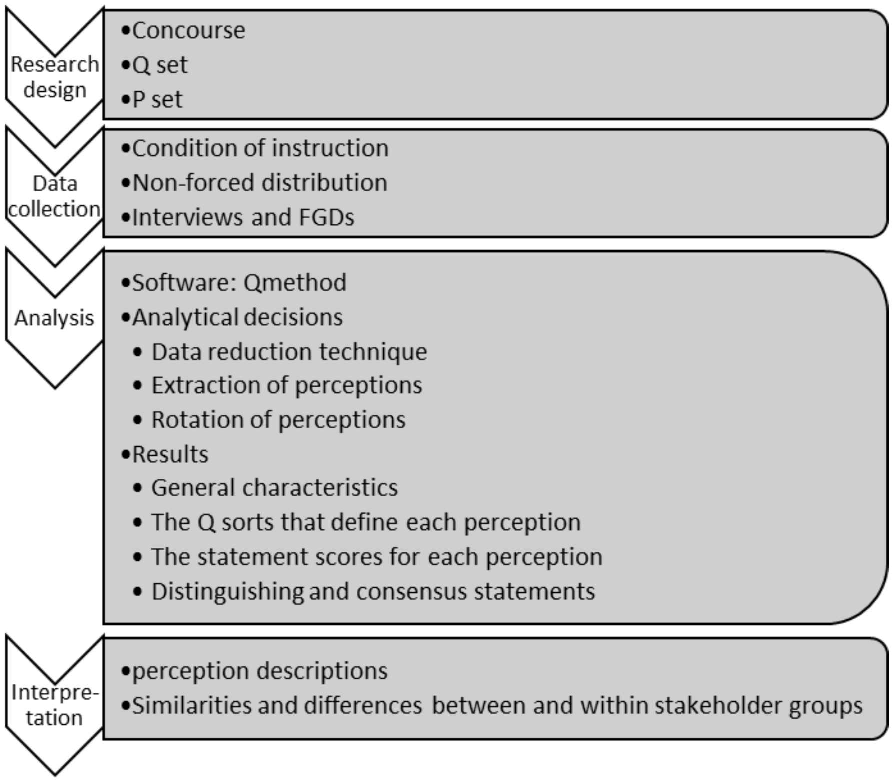


Figure 11: Research process of Q, based on (Zabala, Sandbrook, & Mukherjee, 2018).

Firstly, 17 statements (the Q set) were created based on a literature review (the concourse). Section 1.2 presents this literature review that makes up the concourse of Q and Appendix D.1 presents the statements. After identifying the key stakeholders (the P set), interviews and focus group discussion (FGDs) were conducted with 33 respondents to collect the data. The number of respondents in Q studies (in conservation contexts) typically ranges from 26 to 46 (Zabala et al., 2018). Thus; the size of the P set in this study is average. The stakeholders could freely state their level of agreement for each statement on a five-level scale; see Figure 12. The ranked statements of a stakeholder are referred to as the Q sort.

☐ + +	☐ +	☐ ?	☐ -	☐ - -
+2	*+1*	*0*	*-1*	*-2*
(Fully agree)	*(Agree)*	*(Neutral/don't know)*	*(Disagree)*	*(Strongly disagree)*

Figure 12: Condition of instruction.

Additionally, stakeholders could give a short reason for their choice. See Appendix E for the interview and FGD formats and Appendix D.2 for the procedures and collected data.

For the analysis the Qmethod package (Zabala, 2014) in R software was applied. The main reason for choosing this method is the clear and synthetic report on distinguishing and consensus statements. The analysis consists of two parts; the analytical decisions and the results. The Q sort was analysed through principal component analysis (PCA) to reduce all responses to 3 distinct perceptions representing those who share similar views. The number of perceptions to be extracted was determined through 3 criteria; see Appendix D.3. Next, varimax rotation is applied to obtain a clearer and simpler structure of the data. This rotation can be done either manually or mathematically, but Qmethod currently only allows mathematical rotation. Varimax is the most commonly used rotation (Zabala et al., 2018), so it is also applied in this study. Varimax rotation retains the assumption that the perceptions are orthogonal to each other and have unit variance while it attempts to minimize the number of variables with high loadings on each perception (Saigal, Borgoyary, & Lal, 2005).

Having determined the number of perceptions to extract, the analysis was run again. The results then consist of three components. Firstly, the extent to which a respondent represents a perception is called the loading of Q sorts. The higher a respondent's loading on a perception, the more representative she is of that perception. QMethod then automatically assigns (i.e. flags) stakeholders to the perception with the highest loading. Automatic flagging is based on the two criteria that the loading should be significantly high and the square loading for a perception should be higher than the sum of the square loading for all other perceptions (Zabala, 2014). Secondly, the statement scores consist of the z-scores, which indicate the relation between statements and perceptions. They are a weighted average of the scores given by the Q sorts that represent that perception. Thirdly, distinguishing and consensus statements were obtained. The comparison of absolute differences between perception z-scores indicate whether a statement is consensus or distinguishing. A statement is consensus when there are similar z-scores across all perceptions and a statement distinguishes a perception if it has a significant different z-score compared with the other perceptions. Additional information on the methodology and results of the analysis can be found in Appendix D.

The final step of Q consists of the actual construction of the perceptions. Firstly, the perceptions were described through exploring the following results of the Qmethod analysis:

- The relative position of statements within the grid. Statements that are both distinctive and with extreme scores tend to be most useful for interpretation.
- The position of a statement in a perception versus the position of the same statement in other perceptions
- Distinguishing and consensus statements
- Reasons of stakeholders for their rankings

Next, the distribution of perceptions within stakeholder groups was investigated. This was done by creating a clear overview of the distribution of perceptions amongst the stakeholders and by examining the relation of each stakeholder to a perception.

3.2. Key stakeholders

The farmers in Getas and Pitu use both agroforestry systems and monocropping systems, but they are threatened by water-related problems, such as unreliable water availability, droughts, and floods. This section presents key stakeholders that are related to this water issue.

The village farming community

The farmers of Getas and Pitu apply the farming practices for their crops in their lands. When policy-makers or leaders want to implement new farming methods or stimulate the use of certain farming practices, it is very useful to know the perceptions of those who should apply these practices. See the previous chapter for socio-economic data of this community.

Local government

The local government is responsible for the planning and development of the districts. Therefore, they certainly have an important role in issues inside their districts. The government operates on all administrative levels of Indonesia (see Appendix A). For this project, the district governments of Blora and Ngawi will be interviewed. The district governments are referred to as '*bappeda*'.

Perum Perhutani

Perum Perhutani, a state-owned enterprise managing state forests on Java, was the owner of KHDTK before the Faculty of Forestry obtained the rights to manage the area. Perhutani implemented '*Pengelolaan Sumber daya Hutan Bersama Masyarakat*' (PHBM) which translates to 'collaborative community forest management'. This program set up an institution which allowed a partnership and collaboration between Perhutani KPH Ngawi and the local village communities. This institution is called '*Lembaga Masyarakat Desa Hutan*' (LMDH) which translates to 'forest village community institution'. Perhutani then approached PHMB through forest management units called '*Resort Pemangkuan Hutan*' (RPH) which translates to 'forest trimming resort'. Perum Perhutani and the Faculty of Forestry have collaborated in the past in research initiatives, such as a social forestry program and the application of intensive silvicultural techniques. They thus maintain a positive relationship. Although Perhutani is the former manager of the study area, they now assist UGM in managing the area.

UGM Faculty of forestry

UGM is the new manager of KHDTK since 2017. UGM hopes to create forest management model of KHDTK through sustainable forest management. This will be done by a social forestry approach based on HPD. The aim of HPD is to return the forest as part of the village ecosystem to realize a smart collaboration between forest and village areas. UGM management aims to strengthen LMDH but it is not based on the RPH level that Perhutani used, but on an HPD level. The main difference is that the management units will now be based on the areas of state forests in village areas.

Watershed Office

The KHDTK area is passed by the Bengawan Solo tributary. The Watershed Office (Balai Pengelolaan Daerah Aliran Sungai dan Hutan Lindung (BPDASHL) in Solo manages the catchment area of the Bengawan Solo river and they are thus a key stakeholder in the water issue of KHDTK.

3.3. The perceptions

This sub-chapter identifies and analyses the perceptions of the key stakeholders on the effects of different farming practices on water use in the farming lands. This identification and analysis were done using the Qmethod package in RStudio.

Description of statistical results

Three perceptions are retained for a total share of explained variance of 75.2%, representing respectively 29.6%, 28.5%, and 17.1%. This percentage may be considered high, which suggest the comprehensiveness of the results in explaining the perceptions of the stakeholders based on these three perceptions. See Table D - 6: in Appendix D.3 for an overview and elaboration of these characteristics.

A comparison of absolute differences between z-scores indicate whether a statement is consensus, distinguishing, or non-structuring. The z-scores are a weighted average of the scores given by the Q sorts that represent that perception. The consensus statements reveal the agreement amongst stakeholders and the non-structuring statements do not belong to any specific perception whereas the distinguishing statements identify the different perceptions of the stakeholders. In Appendix D.3, see Table D - 8: for the perception z-scores ranked in order of the statements. For an explanation of how consensus, distinguishing, and non-structuring statements have been identified, also see Appendix D.3 and Table D - 9:.

Perceptions among stakeholder groups

The perceptions between stakeholder groups are presented in Table 3.

Table 3: Composition of the stakeholders that share a perception.

Perception	Village community	Local government	Perhutani	UGM	Watershed
A	-	44%	67%	25%	25%
B	Getas	56%	33%	50%	-
C	Pitu	-	-	25%	50%

The perceptions are roughly equally divided with 8 stakeholders representing the first perception, 9 stakeholders representing the second perception, and 4 stakeholders representing the third perception.

Consensus in all perceptions

Figure 13 presents a visualisation of the perception z-scores, order from the highest consensus (bottom) to the highest disagreement between perceptions (top). This shows the relatively high consensus between perceptions.

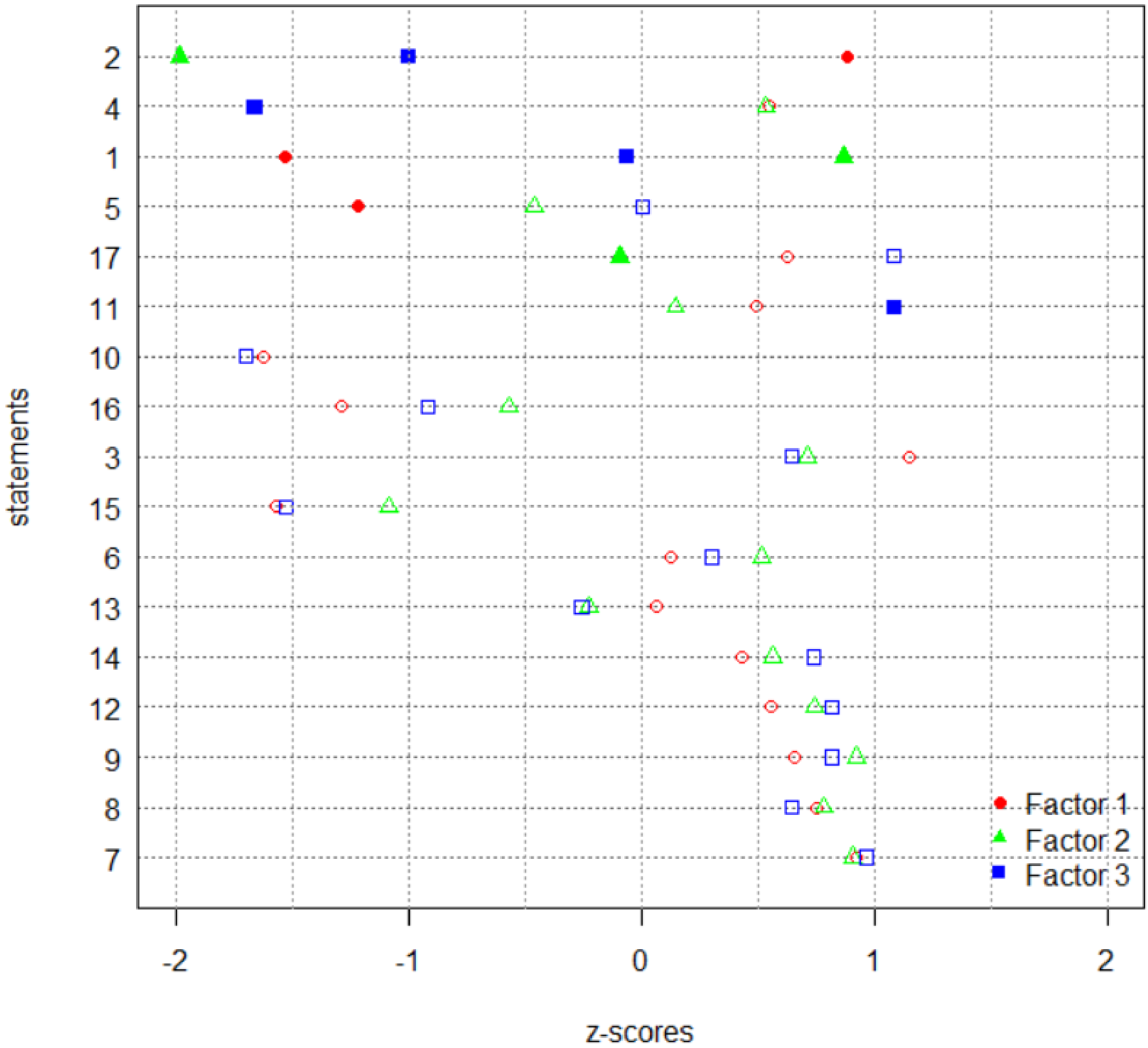


Figure 13: The z-scores for the statements, ordered from highest consensus (bottom) to highest disagreement (top). The distinguishing perceptions are filled; Factor 1 represents perception A, Factor 2 represents perception B, and factor 3 represents perception C.

Table 4 presents an overview of the consensus and non-structuring statements in all three perceptions with their z-scores. The non-structuring statements will be considered as consensus statements since they all disagree to a certain extent.

Table 4: Overview of consensus and non-structuring statements with corresponding z-scores of the perceptions. The greener a cell value is, the stronger the expressed agreement is, and the redder a cell value is, the stronger the expressed disagreement is.

Number	Statement	PerceptionA	PerceptionB	PerceptionC
Consensus statements				
3	Increasing the number of trees improves the water availability at a regional scale	1.15	0.71	0.65
6	Trees reduce the surface runoff of water in farming lands	0.13	0.52	0.3
7	Are you interested in understanding how different farming practices affect the water use of the farming lands?	0.92	0.91	0.97
8	Are you interested in understanding how agroforestry systems and monoculture systems affect the water use of the farming lands differently?	0.75	0.79	0.65
9	I believe that agroforestry systems and monocropping systems are different in their water use	0.66	0.92	0.82
12	I believe agroforestry systems reduce the risks of floods	0.56	0.74	0.82
13	In this area, there are mostly monocropping systems (compared to agroforestry systems)	0.07	-0.23	-0.26
14	We try/encourage farmers to include trees on the farming lands	0.43	0.57	0.74
Non-structuring statements				
15	I prefer monocropping systems compared to agroforestry systems since trees use too much water	-1.57	-1.08	-1.53
16	When applying agroforestry, I worry about the competition between trees and crops for available soil water	-1.29	-0.57	-0.92

A strong consensual attitude is observed on the desire to understand the effect of different farming practices on the water use in the farming lands (statement 7). Although there is also a strong consensual attitude to understanding how agroforestry systems and monocropping systems affect water use differently (statement 8), it is weaker expressed compared to statement 7. Farmers give more practical reasons, since new knowledge could give opportunities for new ways of income. However, they also state that they are not interested if this new knowledge does not help or if it makes their practices more difficult. Other stakeholders state that deeper knowledge and quantitative data is needed to gain insight in the best combination of crops and trees to increase the water use efficiency and the water reserved in the soil. All groups strongly agree that agroforestry systems and monocropping systems are different in their water use (statement 9). These systems have different types of species and apply different planting patterns and planting compositions; factors which affect the water use of a system. In addition, there is a shared view that increasing the number of trees will improve the water availability at a regional scale (statement 3) and consequently farmers try and are encouraged to include trees on the farming lands (statement 14). This is ascribed to roots stocking water and trees improving the soil structure, which increases the capacity to store water. However, it is recognized that different species have a different water use, which can also influence the water availability negatively. Also, including trees sometimes has a more practical purpose of providing a fresh resting place according to farmers. A consensus is also observed on the belief that agroforestry systems reduce the risk of floods (statement 12) and on trees reducing surface runoff (statement 6), although the latter is with a weaker agreement. This is ascribed to trees increasing the water infiltration capacity of the soil, reducing soil erosion, and slowing down water speed. However, some immediately state that there are also other systems that can be applied to reduce these risks. Furthermore, there is a shared neutral position whether there are more monocropping systems or agroforestry systems in the study area (statement 13). Some state that there are slightly more monocropping systems because farmers prioritize the economic advantages of these systems over the conservation benefits of agroforestry systems. Stakeholders that are less closely connected to the study area tend to state that they do not know the exact balance between the systems.

As for the non-structuring statements, there is a shared consensus that trees using too much water is not the decisive factor in preferring monocropping systems compared to agroforestry systems. Consequently, there is also a consensus, albeit with a different level of agreement, that there is no need to worry about competition for available soil water between trees and crops.

The three perceptions

Table 5 presents the statements that distinguish all three perceptions. Table 6 then presents the distinguishing statements for each perception.

Table 5: Statements distinguishing all three perceptions with their z-scores. The greener a cell value is, the stronger the expressed agreement is, and the redder a cell value is, the stronger the expressed disagreement is.

Number	Statement	PerceptionA	PerceptionB	PerceptionC
1	The water use of an agroforestry system is higher than the water use of a monocropping system	-1.5	0.87	-0.07
2	Monocropping systems demand more water than agroforestry systems	0.89	-1.98	-1

Table 6: Statements clearly distinguishing each perception from other perceptions with their z-scores. The greener a cell value is, the stronger the expressed agreement is, and the redder a cell value is, the stronger the expressed disagreement is.

Number	Statement	PerceptionA	PerceptionB	PerceptionC
Distinguishing perception a from the other perceptions				
5	Trees are consumers of available water and are competitors for other water users (such as crops)	-1.2	-0.46	0.01
Distinguishing perception b from the other perceptions				
10	In my opinion, all farming systems (agroforestry and monocropping) have a similar water demand for their farming lands	-1.6	-2.3	-1.7
17	I apply/We encourage farmers to apply agroforestry for soil and water conservation of the farming lands	0.63	-0.09	1.08
Distinguishing perception c from the other perceptions				
4	The roots of the trees soak in water during the rainy season, and release the water during the dry season	0.55	0.54	-1.66
11	In my opinion, agroforestry systems are a reliable tool for soil and water conservation on farming lands	0.49	0.15	1.08

Perception A

The first perception explains 29.6 % of the total variance and is related to 8 Q sorts. While other perceptions reject this view, this perception strongly disagrees that the water use of an agroforestry system is higher than that of a monocropping system (statement 1) and consequently agrees that monocropping systems demand more water (statement 2). Thus, according to this view, trees certainly do not consume available water and do not compete for water with crops (statement 5). Stakeholders in this view state that trees store water and crops can therefore use the water from the trees. Also, the roots of trees access a deeper water level than the shallower roots of crops. This perception states to encourage farmers to apply agroforestry systems for soil and water conservation (statement 17), but this expression is less strong compared to perception c. Compared to other perceptions, it has the strongest agreement that trees improve the regional water availability (statement 3), but it has a less strong expression on the other benefits of agroforestry systems. It slightly agrees that the roots of trees soak in water during the rainy season and release it during the dry season (statement 4). In addition, it is least confident that trees reduce runoff (statement 6) and reduce the risk of floods (statement 12). Due to this weaker confidence of the benefits of agroforestry systems this perception is the least encouraging to include trees in farming lands (statement 14). The knowledge in this perception is relatively low, while the attitude towards agroforestry systems is very positive.

Perception B

The second perception explains 28.5% of the total variance and it relates to 9 Q sorts. Contrary to other perceptions, this perception states that the water use of an agroforestry system is higher than the water use of a monocropping system (statement 1). Consequently, it strongly disagrees that monocropping systems demand more water than agroforestry systems (statement 2). Compared to other perceptions, this perception expresses very strongly that different farming practices have different water demands (statement 9 and 10). Contrary to other perceptions, it is neutral in its belief that agroforestry systems are a reliable tool for soil and water conservation on farming lands (statement 11). Stakeholders state that there are also other systems than can be applied to improve conservation. Consequently, this perception is also neutral in encouraging farmers to apply agroforestry specifically for soil and water conservation (statement 17). However, it does recognize some conservation benefits of agroforestry systems. It agrees, albeit not very strongly, that trees increase the regional water availability (statement 3) and that the roots of trees soak in water during the rainy season and release it during the dry season (statement 4). This is because trees improve the soil structure and increase the soil's capacity to store water. Also, it slightly disagrees with the view that trees are consumers of available water and compete with crops (statement 5), since trees absorb water from a deeper soil level than crops. Furthermore, compared to the other perceptions, it expresses most strongly its agreement with trees reducing surface runoff (statement 6), and reducing the risks of floods (statement 12) because of an increased infiltration capacity of the soil. Although this view is relatively confident in explaining the benefits of an agroforestry system, it is sceptical of its application in farming lands since there are other systems available to ensure conservation. However, it does encourage farmers to include trees in their lands (statement 14), not per se for its conservation benefits, but for its contribution to a resting place for farmers, for the restoration of forests, and for the more efficient water use due to resource sharing. Thus, generally, the knowledge in this perception is less shallow, while the attitude towards agroforestry systems is sceptical.

Perception C

The third perception explains 17.1% of the total variance and is related to 4 Q sorts. Contrary to the other perceptions, it has a neutral position whether the water use of an agroforestry system is higher than the water use of a monocropping system (statement 1). However, it disagrees with monocropping systems demanding more water than agroforestry systems (statement 2). Stakeholders state that the water use is dependent on the species, planting pattern and composition, and not solely on the system. However, the crop yield in agroforestry systems is lower, so this could account for a higher water use in agroforestry systems. Compared to other perceptions, this perception most strongly encourages farmers to apply agroforestry systems for soil and water conservation (statement 17), since it is a reliable tool (statement 11). It states most strongly that agroforestry systems reduce the risks of floods (statement 12) and it also states that it reduces runoff (statement 6). This is because trees increase infiltration and reduce erosion. However, this perception also states its perceived disadvantages of agroforestry systems most strongly. In contrast to other perceptions, this perception strongly disagrees that roots of trees soak up water in the rainy season and release it during the dry season (statement 4). Also, it slightly agrees that trees are consumers of available water and compete with crops (statement 5) for water, sunshine, and fertilizers. This results in a lower crop yield, compared to monoculture systems. Stakeholders state that, although trees could be storing water, there is no signal in the dry season of this water. Thus, this perception is very confident in some of the conservation benefits of agroforestry systems, but it also recognizes a competition between trees and crops, resulting in an economic disadvantage. Despite this economic disadvantage, this perception most strongly states to encourage farmers to include trees in their farming lands (statement 14) for its conservation and diversity benefits, and ecosystem balance.

3.4. Distribution of perceptions within stakeholder groups

The perceptions of the key stakeholders have been identified and analysed. This section investigates how these perceptions are distributed within stakeholder groups. Each stakeholder is assigned to a perception and the higher a stakeholder's loading on a perception, the more representative she is of that perception. Table 7 presents an overview of these perception loadings and it shows the assigned perception to each stakeholder. This table clearly indicates that stakeholders within a stakeholder group have different perceptions.

Table 7: The perception loadings presenting the relation between each respondent and each perception. Grey cells indicate the assigned perception.

Stakeholder	Perception A	Perception B	Perception C
Getas community	-0.09	0.74	0.38
Pitu community	-0.07	0.25	0.68
Bappeda Blora 1	0.26	0.72	0.40
Bappeda Blora 2	0.31	0.81	0.24
Bappeda Ngawi 1	-0.04	0.88	0.02
Bappeda Ngawi 2	0.81	0.16	0.44
Bappeda Ngawi 3	0.85	0.22	0.18
Bappeda Ngawi 4	0.89	0.27	0.07
Bappeda Ngawi 5	-0.04	0.77	0.22
Bappeda Ngawi 6	0.38	0.68	0.11
Bappeda Ngawi 7	0.68	0.10	0.14
Perhutani 1	0.47	0.66	0.43
Perhutani 2	0.86	0.26	0.23
Perhutani 3	0.66	-0.01	-0.30
Watershed 1	0.51	0.60	0.47
Watershed 2	0.29	0.56	0.64
Watershed 3	0.38	0.28	0.74
Watershed 4	0.74	-0.05	0.16
UGM1	0.77	0.13	0.54
UGM2	0.55	0.71	-0.08
UGM3	0.45	0.30	0.77
UGM4	0.13	0.79	0.44

The farming community

The farmers in Getas belong to perception B, while the farming community in Pitu belongs to perception C. This shows that farmers in Getas tend to belief that agroforestry systems have a higher water use than monocropping systems, while Pitu farmers state that the water use of a system does not matter that much since all systems are rain-dependent. Also, Pitu farmers are more explicit in stating disadvantages of agroforestry systems, such as a lower crop yield due to less sunshine or less water.

The local government and Perhutani

The local governments and Perhutani share perception A and perception B equally, although Bappeda Blora only belongs to perception B. Thus, there is a tension between those stating that monocropping systems have a higher water use (perception A) versus those stating that agroforestry systems have a higher water use (perception B). Furthermore, those who share perception A are generally confident that agroforestry systems are a good application for soil and water conservation in the farming lands, while those who share perception B are slightly more sceptical of this. However, those sharing perception B are more confident in stating the benefits of agroforestry systems compared to those belonging to perception A.

The watershed office

The watershed office belongs to perception A and perception C. However, their loadings are relatively high on all three perceptions, indicating a close relation to all perceptions. Consequently, the Q sort of one of the stakeholders is not assigned to one perception, because it is so closely related to more than one perception. Generally, the watershed office is very careful in stating that a certain system has a higher water use than another system because this depends on other factors such as the type of plant and cropping pattern. These factors then also determine the extent of competition between trees and crops. Furthermore, the watershed office is confident in interpreting the benefits of agroforestry systems and regards it as a solution where everyone benefits because the land is conserved while farmers keep their livelihood.

UGM

UGM shares all three perceptions. Thus, UGM represents different beliefs on which system has the highest water use. Also, there are different confidence levels in stating and explaining benefits or disadvantages of agroforestry systems, due to the different functions people have. However, there is a shared belief that a suitable combination of species and planting pattern is crucial for a successful agroforestry system that avoids resource competition and improves resource sharing. Consequently, successful management of agroforestry leads to a more sustainable forest in the study area.

3.5. Discussion

In chapter 3.2 five key stakeholder groups have been identified. If another important group is missed out, their perceptions can probably be found in the range of perceptions as reported in section 3.3.

Then, for section 3.3 and 3.4 Q is applied to identify, analyse, and interpret the perceptions. Q brings a level of abstraction into the identification of perceptions, but this allows for a very systematic and ordered identification. Besides, the application of Q gains insight in the variety of stakeholder perceptions rather than analysing the extent to which these perceptions occur among the wider stakeholder population. Due to resource and time constraints in this study, this is one of the main advantages of Q. Q can be used with a small, selected sample for it does not intend to generalize the results to a larger population. Therefore, the results are representative for the population of perceptions rather than for the population of stakeholders (Cuppen, Bosch-Rekveldt, Pikaar, & Mehos, 2016). Consequently, we do gain insights in the variety of perceptions within and between stakeholder groups, but we do not know the exact distribution. Next, the Q set in this study consists of 17 statements, while generally average Q sets consist of 37 statements (Zabala et al., 2018). However, due to time and resource constraints in both the data collection and the analysis and interpretation phase, this relatively small Q set was used. If a larger Q set had been used, the perceptions might have been more detailed, but a larger Q set would have been destructive for the involvement of the stakeholders. A strength of Q is that it provides a structured way of collecting data, sorting the data, and extracting perceptions. However, during the application the analysist must make some interpretations, such as the number of perceptions to extract. See Appendix D for the verification of these interpretations. Furthermore, there are many consensus statements and fewer distinguishing statements. This indicates a strong common basis for all three perceptions.

3.6. Conclusion

The key stakeholders that are related to water issues in the study area are the village community of Getas and Pitu, the local governments in Blora and Ngawi, Perum Perhutani, UGM, and the watershed office. Using Q methodology, consensus amongst stakeholders and three distinct perceptions have been identified. The number of consensus statements is relatively many (10 statements of 17) and they describe the common basis for all three perceptions. This common basis can be described as a strong interest for a deeper insight in the extent to which varying farming practices affect the water use in the farming lands differently. All perceptions state the following as benefits of agroforestry systems:

- Increasing the number of trees improves regional water availability
- Agroforestry systems reduce the risk of floods
- Trees reduce surface runoff in the farming lands

In addition, stakeholders state not to be worrying about trees using too much water or competition between trees and crops for available soil water when applying agroforestry systems. Consequently, all perceptions are encouraging to include trees in the farming lands.

Perception A is represented by the local government, Perhutani, UGM, and the watershed office. It strongly states that monocropping systems have a higher water use than agroforestry systems and the stakeholders are confident that agroforestry systems are a good application for soil and water conservation. However, this perception is relatively weak in identifying benefits or disadvantages of both systems. Due to this weaker confidence of the benefits of agroforestry systems this perception is the least encouraging to include trees in farming lands. The knowledge in this perception is relatively shallow, while the attitude towards agroforestry systems is very positive. Perception B is represented by the farming community of Getas, the local government, Perhutani, and UGM. It states that agroforestry systems have a higher water use than monocropping systems. Although this perception is more confident in identifying benefits of agroforestry systems, it is sceptical of its application for soil and water conservation in the farming lands since there are also other systems available. However, it does encourage farmers to include trees in their lands, not solely for its conservation benefits, but for its contribution to a resting place for farmers, for the restoration of forests, and for the more efficient water use due to resource sharing. The farming community tends to focus on the more practical aspects, such as trees providing a fresh resting place, while the other stakeholders reveal a deeper knowledge. Thus, generally, the knowledge in this perception is less shallow, while the attitude towards agroforestry systems is sceptical. Perception C is represented by the Pitu farming community, UGM, and the watershed office. It states that water use is not defined solely by its system, but by factors such as species and planting pattern and composition. However, they do add that the crop yield in agroforestry systems is lower, which could account for a higher water use in agroforestry systems. This perception is very confident in some of the conservation benefits of agroforestry systems. Contrary to other perceptions, the stakeholders, and especially the farmers, also recognizes a competition between trees and crops, resulting in an economic disadvantage. Despite this economic disadvantage, this perception most strongly states to encourage farmers to include trees in their farming lands for its conservation and diversity benefits, and ecosystem balance.

All stakeholder groups represent two or even all three perceptions. Thus, within stakeholder groups there are different knowledge levels and different levels of confidence in stating one's level of agreement. The farmers of Getas focus on agroforestry systems having a high water use, while Pitu farmers state that this does not matter since all systems are rain-dependent. Next, there is a discord in the local governments and Perhutani whether monocropping systems or agroforestry systems have a higher water use. The watershed office has a close relation to all three perceptions, but generally the office is confident in interpreting the benefits of agroforestry systems and regards it as a solution where everyone benefits because the land is conserved while farmers keep their livelihood. UGM also shares all three perceptions. However, there is a shared belief that successful management of agroforestry leads to a more sustainable forest in the study area.

4. CONSIDERATIONS FOR MANAGEMENT AND DEVELOPMENT

This chapter gives an answer to the third research question: '*What are considerations for future management and development of the study area?*'. Section 6.1 presents the methodology. Section 6.2 then presents the common basis for future management and development based on the consensus amongst stakeholders. Following, section 6.3 explores focus points based on the distinct perceptions. Section 6.4 and 6.5 respectively discuss the findings and present a conclusion.

4.1. Methodology

Chapter 2 presents a description of the farming lands with the water availability in Getas and Pitu. Chapter 3 then identifies three distinct perceptions of key stakeholders, through application of Q, on the effects of agroforestry and monocropping systems on the water use in the farming lands. This chapter gives considerations for future management and development based on the findings of the previous two chapters. The consensus amongst stakeholders was used to create a common basis for future management and development, while the distinct perceptions were used to identify focus points. The findings of chapter 4 were then used as an input for additional interpretations and consequences.

4.2. Common basis

There is a relatively large consensus amongst the three identified perceptions. This consensus leads to a common basis for future management and development of the study area.

All stakeholders have expressed a strong interest for a deeper insight in the extent to which varying farming practices, such as agroforestry and monocropping systems, affect the water use in the farming lands differently. Thus, there is a need for research. On the one hand, there is a need for a research to quantify the water use of agroforestry systems and monocropping systems in general. On the other hand, specific studies into the best combination of crops and trees in Getas and Pitu is needed. Most farming systems in the study area are rain dependent, so the water use efficiency and resource sharing capacity of a system are crucial factors to the success of a system. Next, all perceptions, to some extent, state to believe in several benefits of agroforestry systems. This consensus amongst all stakeholders can be used as a common ground in discussions.

4.3. Focus points

Stakeholders believe in contradicting benefits and disadvantages of farming systems. Therefore, it is important to carefully examine which benefits are true and which are based on myths. For example, the truth of the statement that the roots of trees soak in water during the rainy season and release this during the dry season should be investigated. Perception C strongly disagrees with this statement while the other perceptions agree with this benefit. Following, the knowledge of the stakeholders should be increased or 'updated'.

Next, the distinct perceptions indicate that there are different focus points in the described common basis. Getas farmers belong to perception B, while Pitu farmers represent perception C. Both Getas and Pitu are highly dependent on state forests (see chapter 4.2). To prevent village communities from changing forest area into monoculture area, farmers should be encouraged to apply more agroforestry systems in farming lands. Although, both communities state that agroforestry systems have a higher water use, they also both recognize benefits of agroforestry systems. UGM favours agroforestry systems over monocropping systems in the Getas-Ngandong forests. Consequently, the benefits of agroforestry systems should be emphasized on. However, the knowledge of the farming community is relatively shallow and based on their observations. Increasing their understanding of the benefits and disadvantages of farming systems will assist in choosing farming systems. Also, it should be very clear to the farming communities why the conservative benefits of agroforestry systems are surpassing the disadvantages of a higher water use and subsequent lower crop yield. This is especially important in Getas, for in Pitu already half of the agroforestry systems is applied in community owned lands.

Moreover, every stakeholder group represents two or even all three perceptions. Thus, within stakeholder groups there are different knowledge levels and tensions between those with different attitudes or beliefs. For example, in the local governments and Perhutani, there are those who belief monocropping systems have a higher water use and those who state that agroforestry systems have a higher water use. Also, there are different beliefs to the extent of agroforestry systems being a suitable application for soil and water conservation. Consequently, it is not possible to address a stakeholder group in one way, but all the different perceptions that are represented in a stakeholder group should be considered.

4.4. Discussion

Using the findings of chapter 2 and chapter 3, considerations for future management and development for the study area have been made. Consequently, the considerations are limited to the extensiveness of the findings and are thus focusing on hydrology related issues, such as water availability in the study area and the hydrological benefits and disadvantages of farming systems. The relatively large areas of consensus amongst all stakeholder groups leads to a solid common ground for this future management and development. However, there is a contradicting belief that prevails in all stakeholder groups on the extent of the water use of different farming systems. Therefore, an increased understanding of the water use of agroforestry and monocropping systems, specifically in Getas and Pitu, and the transmission of knowledge in different stakeholder groups are key elements in the management and development of the study area. This diffusion of knowledge could be a long process since myths tend to persist in the beliefs of people. However, if all stakeholder groups acknowledge the (true) effects of agroforestry and monocropping systems on the water use in the farming lands, it could lead to an increased use of agroforestry systems. Consequently, this will contribute to a maximisation of the productivity and efficiency (due to e.g. resource sharing in agroforestry systems) of the forest and forest-farming systems.

4.5. Conclusion

The consensus amongst all stakeholders leads to a common basis for future management and development of the study area. Firstly, for the development of the area the water use of agroforestry and monocropping systems should be quantified and the optimal combination of crops and trees in the Getas and Pitu should be explored. Secondly, each stakeholder group represents two or even all three perceptions. Thus, within stakeholder groups there are different knowledge levels and stakeholders believe in contradicting benefits or disadvantages of farming practices. Consequently, when managing the stakeholders, it is not possible to address a stakeholder group in a one specific way, since each group represents several perceptions. In addition, it is important to carefully identify those beliefs that are true and those that are based on myths (e.g. roots storing water and releasing it in the dry season). Furthermore, the farming communities of Getas and Pitu both recognize some benefits of agroforestry systems and this could be used as a basis to encourage them to apply more agroforestry systems. The communities are highly dependent on state forests and this could prevent them from changing forest areas into monoculture areas. Also, it should be very clear to the farming communities why the conservative benefits of agroforestry systems are surpassing the disadvantages of a higher water use and subsequent lower crop yield.

5. CONCLUSIONS AND RECOMMENDATIONS

Chapters 2,3, and 4 have presented and discussed the findings of the research questions. In addition, these chapters have presented elaborate conclusions. Section 5.1 now presents the combined conclusions and thus answers the research objective. Next, section 5.2 gives recommendations.

5.1. Conclusion

How can the farming practices with their water use in the study area be described?

The farming communities in both Getas and Pitu have a high dependency on state forests. In Getas, most agroforestry systems are applied in state forests. However, Pitu depends less on state forests and applies agroforestry systems in both state forests and community-owned forests. In both Getas and Pitu maize, sugarcane, and rice are the most grown crops in agroforestry systems and monocropping systems. Furthermore, farmers in Getas and Pitu generally have a rainfed agriculture. Thus, during the dry season or periods of drought, there is often no farming activity, unless farmers use irrigation systems. Consequently, in the rainy season the attitude to water availability is positive and in the dry season primarily negative. However, the presence of springs provides opportunities to use irrigation systems in both areas, but farmers in Pitu can also irrigate from the Bengawan Solo river. This partly accounts for the more positive attitude of Pitu farmers compared to Getas farmers to general water availability. Additionally, crops such as maize and sugarcane are generally cultivated on hilly areas, so floods do not influence these farming lands. Farmers tend to plant wet rice fields in monocropping systems in valleys or near flood sensitive rivers while dry rice fields are often cultivated in agroforestry systems. Consequently, lands with monocropping systems are situated closer to a river and thus farmers with monocropping systems have a more positive attitude towards water availability than farmers with agroforestry systems.

What are the perceptions of the key stakeholders on the effects of different farming practices on the water use in the farming lands?

The key stakeholders that are related to the water issues in the study area are the village community of Getas and Pitu, the local governments in Blora and Ngawi, Perum Perhutani, UGM, and the watershed office. Q methodology, as employed in this study has helped to identify consensus amongst stakeholders and three distinct perceptions. The number of consensus statements is relatively many (10 statements of 17) and they describe the common basis for all three perceptions. This common basis can be described as a strong interest for a deeper insight in the extent to which varying farming practices affect the water use in the farming lands differently. All perceptions state that agroforestry systems have benefits, such as improving the regional water availability, and reducing the risk of floods and surface runoff in the farming lands. Additionally, stakeholders state not to be worrying about competition between trees and crops for available soil water when applying agroforestry systems. Consequently, all perceptions are encouraging to include trees in the farming lands. Table 8 gives an overview of the distinctions that characterize and define the three perceptions.

Table 8: An overview of the distinctions between the three perceptions, AF refers to agroforestry systems.

	Perception A	**Perception B**	**Perception C**
Represented by	Local government, Perhutani, UGM, the watershed office	Getas farmers, local government, Perhutani, UGM	Pitu farmers, UGM, watershed office
System with highest water use	Monocropping systems	Agroforestry systems	Water use is defined by species and planting pattern and composition
AF as good application for soil and water conservation	Confident	Sceptical	Very confident
Confidence in stating benefits and	Relatively weak	Confident	Very confident

disadvantages of farming systems			
Including trees in farming lands	Least encouraging (conservation benefits)	Encouraging (practical benefits)	Encouraging (conservation benefits)
Specific focus on	Trees do not compete with crops for available soil water	Besides AF there are other systems available to ensure conservation	Competition between trees and crops, economic disadvantages of AF

All stakeholder groups represent two or even all three perceptions. Table 9 gives an overview of the distribution of perceptions and describes the focus points among stakeholder groups.

Table 9: An overview of the perceptions between and within stakeholder groups with their general focus.

	Perception	**Focus**
Getas farmers	B	- Acknowledging that trees use available soil water and compete with crops. - Less sceptical of agroforestry as an application for soil and water conservation.
Pitu farmers	C	- All systems are rain-dependent. - Agroforestry is a relatively new method and they are only interested in it if it helps them and if it does not make crop cultivation more difficult.
Local government and Perhutani	A, B	- General focus on benefits of agroforestry systems. - Tension between those stating that monocropping systems have a higher water use versus those stating that agroforestry systems have a higher water use.
Watershed office	A, C	- Many factors determine the water use of a system and the extent of competition between trees and crops. - Agroforestry systems are a solution where everyone benefits because the land is conserved, while farmers keep their livelihood
UGM	A, B, C	- A suitable combination of species and planting pattern in crucial for a successful agroforestry system avoiding resource competition and improving resource sharing. - Agroforestry systems lead to a more sustainable forest.

What are considerations for future management and development of the study area?

As for the management of the area, it is not possible to address the stakeholder groups in one specific manner, since each group represents several perceptions. Within stakeholder groups there are different knowledge levels and stakeholders believe in contradicting benefits or disadvantages of farming practices. Therefore, it is important to carefully identify those beliefs that are true and those that are based on myths. Then, for the development of the area the water use of agroforestry and monocropping systems should be quantified and the optimal combination of crops and trees in the Getas and Pitu should be explored. Furthermore, UGM favours agroforestry systems and the farming communities of Getas and Pitu both recognize some benefits of agroforestry systems. This could be used as a basis to encourage the communities to apply more agroforestry systems and thus preventing them from changing forest areas into monoculture areas. However, it should be very clear to the farming communities why the conservative benefits of agroforestry systems are surpassing the disadvantages of a higher water use and subsequent lower crop yield.

In conclusion, this research project has described the farming lands with the farming practices and water availability in the Getas-Ngandong forests. Following, it has identified and compared the perceptions of key stakeholders on the effects of agroforestry and monocropping systems on the water use in the farming lands. These findings were then used to present consideration for the development and management of the area.

5.2. Recommendations

KHDTK forest management aims to maximise the productivity and efficiency of the forest and forest-farming systems to increase community welfare. This objective will be achieved by including research activities and participation of all stakeholders in the management and development of KHDTK. This thesis project has described the current situation of farming practices and their water use in Getas and Pitu and it has identified stakeholder perceptions on the water issues of the forest and forest-farming systems. In the future, the specific (hydrological) claims and functions of forests and monocropping and agroforestry practices should be investigated thoroughly. This should be done in the Getas and Pitu area, but also in other KHDTK areas. Next, this study focuses on the hydrology of forests and farming practices, but other studies could be conducted focusing on other elements. For example, the influence of tree species or soil conditions on the productivity and efficiency of the forest and forest-farming systems could be investigated. Furthermore, the identified perceptions reveal a consensus among stakeholders, but also pinpoint divergent attitudes. These can guide awareness-raising campaigns and assist in the process of including stakeholders in the management and development of the area. Additionally, Q methodology has proven to be a structured and systematic way of identifying stakeholder perceptions on hydrological issues. Thus, this methodology could also be applied in identifying stakeholder perceptions in other issues, such as forest conservation.

REFERENCES

Brown, S. R. (1971). The Forced-Free Distinction in Q Technique. *Journal of Educational Measurement, 8*(4), 283-287.

Brown, S. R. (1993). *A Primer on Q Methodology* (Vol. 16).

Bruijnzeel, L. A. (2004). Hydrological functions of tropical forests: not seeing the soil for the trees? *Agriculture, Ecosystems & Environment, 104*(1), 185-228. doi:https://doi.org/10.1016/j.agee.2004.01.015

Butler, R. A. (2010). Indonesia forest information and data. Retrieved from https://rainforests.mongabay.com/deforestation/2000/Indonesia.htm

Calder, I. R. (1998). *Water resource and land use issues* (SWIM paper 3 ed.). Colombo, Sri Lanka: International Water Management Institute (IWMI).

Cannell, M. G. R., Van Noordwijk, M., & Ong, C. (1996). *The central agroforestry hypothesis: The trees must acquire resources that the crop would not otherwise acquire* (Vol. 34).

Central Intelligence Agency. (2018). The World Factbook. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/fields/2097.html

Cuppen, E., Bosch-Rekveldt, M. G. C., Pikaar, E., & Mehos, D. C. (2016). Stakeholder engagement in large-scale energy infrastructure projects: Revealing perspectives using Q methodology. *International Journal of Project Management, 34*(7), 1347-1359. doi:https://doi.org/10.1016/j.ijproman.2016.01.003

Dietz, T., Bymolt, R., Bélemvire, A., Geest, K. v. d., Groot, D. d., Millar, D., . . . Zaal, F. (2013). *PADev guidebook: participatory assessment of development*. Retrieved from http://padev.nl/other_output/PADev_guidebook_2013.pdf

Ellison, D., Futter, M., & Bishop, K. (2012). On the forest cover–water yield debate: from demand- to supply-side thinking. *Global Change Biology, 18*(3), 806-820. doi:10.1111/j.1365-2486.2011.02589.x

FAO. (2009). *How to feed the world in 2050*. Retrieved from http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

FAO. (2015). *GLOBAL FOREST RESOURCES ASSESSMENT 2015*. Retrieved from Rome: http://www.fao.org/3/a-i4808e.pdf

Gilmour, D. (2014). *Forests and Water: A Synthesis of the Contemporary Science and its Relevance for Community Forestry in the Asia–Pacific region*. Retrieved from Bangkok, Thailand:

Guthiga, P. (2008). Understanding Local Communities Perceptions of Existing Forest Management Regimes of a Kenyan Rainforest. *International Journal of Social Forestry, 1*(2), 145-166.

Hamilton, L. S. (1983). *Tropical forested watersheds : hydrologic and soils response to major uses or conversions / by Lawrence S. Hamilton, with Peter N. King*. Boulder, Colo: Westview Press.

Hutton, J. M., & Leader-Williams, N. (2003). Sustainable use and incentive-driven conservation: realigning human and conservation interests. *Oryx, 37*(2), 215-226. doi:10.1017/S0030605303000395

Idris, M. H., & Mahrup, M. (2017). Changes in Hydrological Response of Forest Conversion to Agroforestry and Rainfed Agriculture in Renggung Watershed, Lombok, Eastern Indonesia. *2017, 23*(2), 9.

InfoBlora. (2017). UGM Kelola Hutan Getas-Ngandong Seluas 10.901 Hektar. Retrieved from http://www.infoblora.com/2017/04/ugm-kelola-hutan-getas-ngandong-seluas.html

Jackson, N. A., Wallace, J. S., & Ong, C. K. (2000). Tree pruning as a means of controlling water use in an agroforestry system in Kenya. *Forest Ecology and Management, 126*(2), 133-148. doi:https://doi.org/10.1016/S0378-1127(99)00096-1

Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: an overview. *Agroforestry Systems, 76*(1), 1-10. doi:10.1007/s10457-009-9229-7

Mbow, C., Smith, P., Skole, D., Duguma, L., & Bustamante, M. (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. *Current*

Opinion in Environmental Sustainability, 6, 8-14. doi:https://doi.org/10.1016/j.cosust.2013.09.002
Nair, P. K. R. (1993). *An introduction to agroforestry*. Dordrecht: Kluwer Academic Publishers.
Nusser, S. M., & Klaas, E. E. (2003). Survey methods for assessing land cover map accuracy. *Environmental and Ecological Statistics, 10*(3), 309-331. doi:10.1023/A:1025107023980
Raadgever, G. T., Mostert, E., & van de Giesen, N. C. (2008a). Identification of stakeholder perspectives on future flood management in the Rhine basin using Q methodology. *Hydrol. Earth Syst. Sci., 12*(4), 1097-1109. doi:10.5194/hess-12-1097-2008
Raadgever, G. T., Mostert, E., & van de Giesen, N. C. (2008b). *Measuring perspectives on future flood management on the Rhine: application and discussion of Q methodology* (Vol. 5).
Saigal, S., Borgoyary, M., & Lal, P. (2005). *Incorporating Stakeholder Perceptions in Participatory Forest Management in India*.
Seyni, S., Moula, N., Hamadou, I., Issa, M., Issa, S., Hamani, M., . . . Antoine-Moussiaux, N. (2018). *Q method to map the diversity of stakeholder viewpoints along agricultural innovation systems: A case study on cattle genetic improvement in Niger* (Vol. 61).
Silvano, R. A. M., Udvardy, S., Ceroni, M., & Farley, J. (2005). An ecological integrity assessment of a Brazilian Atlantic Forest watershed based on surveys of stream health and local farmers' perceptions: implications for management. *Ecological Economics, 53*(3), 369-385. doi:https://doi.org/10.1016/j.ecolecon.2004.12.003
Smith, J., Pearce, B. D., & Wolfe, M. S. (2013). Reconciling productivity with protection of the environment: Is temperate agroforestry the answer? *Renewable Agriculture and Food Systems, 28*(1), 80-92. doi:10.1017/S1742170511000585
Steelman, T. A., & Maguire, L. A. (1999). Understanding Participant Perspectives: Q-Methodology in National Forest Management. *Journal of Policy Analysis and Management, 18*(3), 361-388.
Stein, A., & Ettema, C. (2003). An overview of spatial sampling procedures and experimental design of spatial studies for ecosystem comparisons. *Agriculture, Ecosystems & Environment, 94*(1), 31-47. doi:https://doi.org/10.1016/S0167-8809(02)00013-0
Universitas Gadjah Mada. (2017a, 7 April 2017). Restoring Getas-Ngandong Forests, UGM Initiates Java Forests Restoration. Retrieved from https://ugm.ac.id/en/news/13634-restoring.getas-ngandong.forests.ugm.initiates.java.forests.restoration
Universitas Gadjah Mada. (2017b, 17 November 2017). State Secretary Launches Getas-Ngandong Forest as UGM Education Forest. Retrieved from ugm.ac: https://ugm.ac.id/en/news/15190-state.secretary.launches.getas-ngandong.forest.as.ugm.education.forest
Van Exel, J., & Graaf, G. (2005). *Q Methodology: A Sneak Preview*.
Yuwono, T., Rohman, Widayanti, W. T., Riyanto, S., Permadi, D. B., Marhaento, H., . . . Larasati, B. (2018). *Penyusanan rencana pengelolaan sumber daya hutan kawasan hutan dengan tujuan khusus (KHDTK) untuk pendidikan dan pelatihan universitas Gadjah Mada*. Retrieved from Yogyakarta:
Zabala, A. (2014). qmethod: A Package to Explore Human Perspectives Using Q Methodology. *The R journal, 6*(2), 163-173.
Zabala, A., Sandbrook, C., & Mukherjee, N. (2018). When and how to use Q methodology to understand perspectives in conservation research. *Conservation Biology, 32*(5), 1185-1194. doi:doi:10.1111/cobi.13123

Appendix A: Administrative regions in KHDTK

This section explains the administrative regions of the KHDTK area to provide an understanding of the different levels of the described data.

Firstly, there are the official administrative regions of Indonesia. Indonesia is divided into 34 provinces (*Provinsi*). These provinces are subdivided into districts (*Kabupaten*) which are further divided into sub-districts (*Kecamatan*). These sub-districts consist of villages (*Desa*) and these villages consist of sub-villages (*Dusun*).

Next, there are the management boundaries made by UGM. UGM has created boundaries using HPD; the compartments represent the forest areas inside village areas and the boundaries are thus different from the official administrative boundaries; see Figure A - 2. The local community can manage these forests together with UGM. These boundaries will be used for this project. See Figure A - 1 for an overview of the official administrative regions that are located inside the UGM management area of Getas and Pitu.

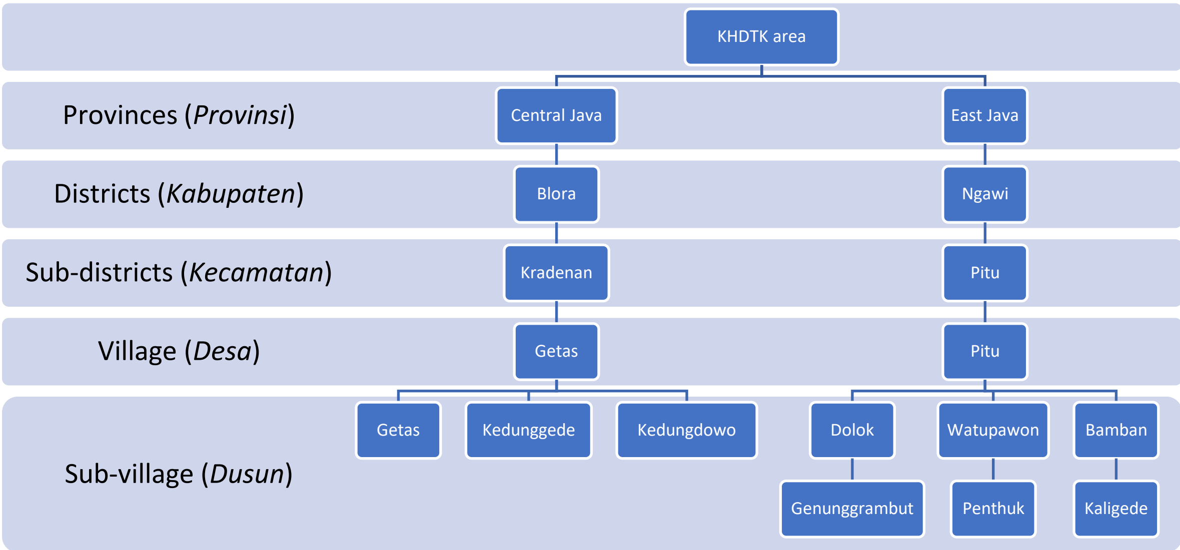


Figure A - 1: Overview of the administrative levels in the study area.

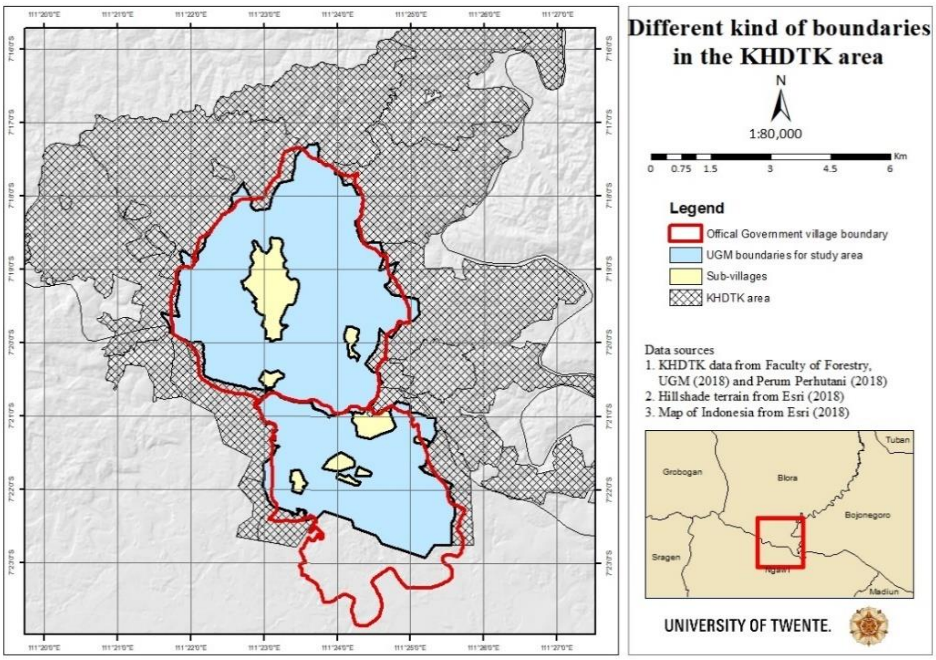


Figure A - 2: Different type of boundaries in the study area.

Appendix B: Water use interviews

B.1 gives an overview of the preparations and procedures of the interviews that were conducted with the farmers on the water use in their farming lands. Then, B.2 presents the interview format.

B.1. Preparations and procedure

Firstly, the interview formats investigating the practices and attitudes of farmers related to water use in the farming lands were made. The interviews include a combination of open questions and multiple-choice questions to ensure comparability between the interviews. A scale of 1 to 10 was used to determine the attitudes of the farmers. Next, the interviews were made in both English and Bahasa to make it easier for the local counsellor, who assisted in interviewing the farmers. Thus, it was important to discuss the interview format with this person before doing the interviews. Moreover, the local counsellor also chose the locations for the interviews. Thus, it was very important to explain the research aim and to discuss the kind of locations that had to be visited.

The procedure for the interviews was as following; firstly, the farming locations were visited. The interview was done at the location if the farmer was there; otherwise, the interview was done at the farmer's house. At the start of the interview, I introduced myself. The local counsellor then carried out the interview (often in Javanese) and translated the answers to English. This translation is then a summarization of the farmer's answer and consequently some information might have been lost.

B.2. Interview format

Date: ____________________________

Name: ____

Location: ____

My name is Rhodé and I am a student from the Netherlands. I am doing my bachelor thesis at the Gadjah Mada University and I want to investigate the water use in this area for different farming practices. I hope you are willing to participate in this interview.

Nama saya Rhodé dan saya seorang pelajar dari Belanda. Saya sedang melakukan tesis sarjana saya di Universitas Gadjah Mada dan saya ingin belajar penggunaan air di daerah ini untuk praktik pertanian yang berbeda. Saya harap Anda bersedia berpartisipasi dalam wawancara ini.

---

1. **How old are you?**
   Berapa usia Anda?
   ☐ < 30
   ☐ 31 - 40
   ☐ 41 - 50
   ☐ > 50
2. **Which crops do you grow on your farming lands?**
   Tanaman apa yang Anda tanam di lahan pertanian Anda?
   ____
   ____

Water availability in this village / Ketersediaan air di desa ini

3. **In my opinion, in general, there is enough water for the crops on the farming lands (1 = I do not agree, 10 = I very much agree) / *Menurut pendapat saya, secara umum, ada cukup air untuk tanaman di lahan pertanian (1 = Saya tidak setuju, 10 = Saya sangat setuju)***
   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10
4. **Where do you get the water for the farming lands during the raining season?**
   Di mana Anda mendapatkan air untuk lahan pertanian selama musim hujan?
   ☐ The river / *sungai:*
   ☐ Irrigation canals / *saluran irigasi*
   ☐ Rainfall / *air hujan*

☐ Other / *lain-lain*:

____

____

5. **In the raining season I can easily get enough water for the crops on the farming lands (1= I do not agree, 10 = I very much agree) / *Pada musim hujan saya dapat dengan mudah mendapatkan air yang cukup untuk tanaman di lahan pertanian (1 = Saya tidak setuju, 10 = Saya sangat setuju)***

   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10

6. **Where do you get the water for the farming lands during the dry season?**
   Di mana Anda mendapatkan air untuk lahan pertanian selama musim kemarau?

   ☐ The river / *sungai:*
   ☐ Irrigation canals / *saluran irigasi*
   ☐ Rainfall / *air hujan*
   ☐ Other / *lain-lain*:

____

____

7. **In the dry season I can easily get enough water for the crops on the farming lands (1= I do not agree, 10 = I very much agree) / *Pada musim kemarau saya dapat dengan mudah mendapatkan air yang cukup untuk tanaman di lahan pertanian (1 = Saya tidak setuju, 10 = Saya sangat setuju)***

   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10

Water use during droughts / Penggunaan air selama kekeringan

8. **How often do droughts occur in a year? / *Seberapa sering kekeringan terjadi dalam setahun?***

   ☐ 1 in a year / *kali dalam setahun*
   ☐ 2-3 in a year / *kali dalam setahun*
   ☐ 4-5 in a year / *kali dalam setahun*
   ☐ other / *lain-lain*:

9. **Where do you get the water for the farming lands during droughts? / *Di mana Anda mendapatkan air untuk lahan pertanian selama kekeringan?***

   ☐ The river / *sungai:*
   ☐ Irrigation canals / *saluran irigasi*
   ☐ Rainfall / *air hujan*
   ☐ Other / *lain-lain*:

____

____

10. **How does a drought influence your water use? / *Bagaimana kekeringan mempengaruhi penggunaan air Anda?***

____

____

Floods / *Banjir*

11. **How often do floods occur in a year? / *Seberapa sering banjir terjadi dalam setahun?***

    ☐ 1 in a year / *kali dalam setahun*
    ☐ 2-3 in a year / *kali dalam setahun*
    ☐ 4-5 in a year / *kali dalam setahun*
    ☐ other / *lain-lain*:

12. **How does a flood influence your water use? / *Bagaimana banjir mempengaruhi penggunaan air Anda?***

____

____

Thank you very much for your time!
Terima kasih banyak atas waktunya!

Appendix C: Q methodology – an introduction

This appendix introduces Q. First, C.1 compares different methodologies to measure perceptions and it identifies Q methodology as most useful for structured elicitation and analysis. Next, C.2 briefly describes Q and C.3 reviews the use of Q in the fields of forestry, agriculture, and hydrology.

C.1. Elicitation methods

There are several methods for identifying stakeholder perceptions. Table C - 1 presents several methods that cover a large part of the available elicitation approaches, although there are more combinations of these and other methods.

Table C - 1: Elicitation techniques, direct results and possibilities for further analysis (Raadgever, Mostert, & van de Giesen, 2008b).

Elicitation technique	**Direct results of elicitation**	**How can they be further analysed?**
Interviewing	Statements about issue	Direct comparison (difficult)
Questionnaire	Statements, categorised answers, scores	Statistical analysis
Card sorting	Taxonomies / classification structures	Direct comparison (difficult)
Cognitive mapping	(Causal) conceptual models	Direct comparison (difficult)
Protocol analysis	Procedural knowledge	Direct comparison (difficult)
Q methodology	Relative scores / ranks of statements	Factor analysis

Thus, Q is the most useful technique for structured elicitation and analysis, since the direct results and the factor analysis ensure the most objective and reproducible grouping of perceptions (Raadgever et al., 2008b).

C.2. Q methodology

Q is a clearly structured, systematic and increasingly-used methodology designed specifically to identify different perceptions in complex issues (Zabala, 2014). Q provides a foundation for the systematic study of human subjectivity (Brown, 1993). It uses the subjective viewpoints of participants to construct typologies of different perceptions using quantitative factor analysis. It then outlines areas of consensus and discord, revealing shared perceptions and differences in perceptions. The methodology was developed by William Stephenson in the 1930s and was used initially in psychology. Stephenson was interested in using factor analysis to correlate people with the views they held to reveal the multiple points of view that could prevail in any situation (Brown, 1993). Thus, Q correlates and factorizes persons instead of traits. Consequently, it does not aim to generate correlation between objective attributes that are abstracted from the individual, such as nationality, gender, and age. Also, Q can be used with a small, selected sample since it does not intend to generalize the results to a larger population (Steelman & Maguire, 1999).

Q consists of the following five basic steps (Van Exel & Graaf, 2005):

1. The concourse; full spectrum of items reflecting all possible opinions around the issue
2. The Q set; selection of most relevant statements
3. The P set; selection of the participants representing different perceptions
4. Q sort; participants rank the statements
5. Analysis and interpretation

C.3. Q in forestry, agriculture, and hydrology

Although Q was initially used in psychology and later in political science, it is now increasingly used in several other fields (Zabala, 2014). Q has also been adopted in the fields of forestry, agriculture, and hydrology. Steelman and Maguire illustrate how Q can be used to better understand participant perceptions in national forest management. They demonstrate how the methodology defines participant viewpoints and perceptions, provides insight into participant-preferred management directions, outlines areas of consensus and conflict, and develops a common view towards a policy (Steelman & Maguire, 1999). Additionally, the methodology has been used to map stakeholder perceptions in participatory forest management in India. The study adopts Q to identify and understand the similarities and differences in stakeholder positions to provide insight into stakeholder perceptions (Saigal, Borgoyary, & Lal, 2005). Furthermore, in the agricultural sector, Q has been used to map the diversity of stakeholder viewpoints along agricultural innovation systems in Niger (Seyni et al., 2018). In the hydrology sector, a study has been done to identify stakeholder perceptions on future flood management in the Rhine basin using Q. Q is found to be useful for setting the research agenda, identifying different perceptions, creating awareness amongst stakeholders, and developing scenarios (Raadgever, Mostert, & van de Giesen, 2008a).

Appendix D: Q methodology – step by step strategy

A Q study can be divided in 4 stages: research design, data collection, analysis, and interpretation (Zabala et al., 2018). The methodology in chapter 3 describes these 4 stages, but this appendix gives additional information in the strategy for these stages.

D.1. Research design

A representative sample of statements (the Q set) was selected which can be ranked by the participants. The statements are categorized according to subcategories; knowledge, attitudes, and practices. The knowledge category aims to investigate the theoretical perceptions on the effects of agroforestry systems and monocropping systems on the water use in the farming lands. The attitudes seek to find out the stakeholders' attitudes towards different farming practices and towards their effects of water use. The practices explore which practices stakeholders (encourage to) apply and their perceived influence of water use in the farming lands. See Table D - 1 for the 17 statements that were used in the interviews and FGDs.

Table D - 1: An overview of the statements.

Type	Number	Statement
Knowledge	1	The water use of an agroforestry system is higher than the water use of a monocropping system
	2	Monocropping systems demand more water than agroforestry systems
	3	Increasing the number of trees improves the water availability at a regional scale
	4	The roots of the trees soak in water during the rainy season, and release the water during the dry season
	5	Trees are consumers of available water and are competitors for other water users (such as crops)
	6	Trees reduce the surface runoff of water in farming lands
Attitudes	7	Are you interested in understanding how different farming practices affect the water use of the farming lands?
	8	Are you interested in understanding how agroforestry systems and monoculture systems affect the water use of the farming lands differently?
	9	I believe that agroforestry systems and monocropping systems are different in their water use
	10	In my opinion, all farming systems (agroforestry and monocropping) have a similar water demand for their farming lands
	11	In my opinion, agroforestry systems are a reliable tool for soil and water conservation on farming lands
	12	I believe agroforestry systems reduce the risks of floods
	13	In this area, there are mostly monocropping systems (compared to agroforestry systems)
Practices	14	We try/encourage farmers to include trees on the farming lands
	15	I prefer monocropping systems compared to agroforestry systems since trees use too much water
	16	When applying agroforestry, I worry about the competition between trees and crops for available soil water
	17	I apply/We encourage farmers to apply agroforestry for soil and water conservation of the farming lands

D.2. Data collection

Condition of instruction

The condition of instruction to the respondents was a request for agreement or disagreement. The respondent was asked to rank the statements on a 5-point scale, ranging from fully agree to strongly disagree. This ranking is called the Q sort. Also, for each statement the respondent was asked to give a short reason for choosing a specific rank. This qualitative data will play an important role in the interpretation of the results.

Non-forced distribution

In many Q studies, a forced distribution is used, forcing respondents to distribute the statements over the score categories according to a symmetric distribution. A forced distribution thus forces respondents to carefully compare the statements relatively to each other. However, some studies have used a non-forced distribution because a forced distribution reduces the response rate (Steelman & Maguire, 1999), is too complex for respondents (Seyni et al., 2018), or requires too much time and effort for respondents and additionally does not express someone's perception well in a given distribution (Raadgever et al., 2008a). Time constraints and reduced complexity were the main factors to adopt a non-forced distribution in this study. This has no significant consequence for the factor analysis (Brown, 1971).

Interviews and FGDs

The data was collected through interviews and FGDs; see Table D - 2 for an overview. As preparation, the local counsellor was guided through the formats to ensure a good understanding of the interview questions. For the interviews, the procedure was as following; an appointment was made with someone in the office. Then, the research aim was explained and the type of people who should be interviewed was made clear. It was very important to interview those people who were responsible for the planning or development in the area and those who had sufficient knowledge of farming practices and water issues. See Table D - 2 for an overview of the positions of the stakeholders. Depending on the available time, 2 to 7 people were interviewed in the offices. At least one person was interviewed by myself; most stakeholders could speak English sufficiently and otherwise the local counsellor would translate. The other interviews were filled in as a survey. A guidebook for a bottom-up and participatory approach presenting detailed methods and procedures for FGDs suggests group sizes of 6 participants (Dietz et al., 2013). Thus, for the FGDs, the local counsellor set up a meeting with 6 farmers. The meeting place was at a farmer's house to gain the trust and openness of the farmers. The FGDs were done at night, since this was more convenient for the farmers. In preparing the FGDs, refreshments were bought for the farmers. First, I introduced myself to the farmers and then the local counsellor explained the procedure to the farmers in Javanese. During the discussions, all farmers were given the opportunity to speak. It was clear to the farmers that they should reach unanimity in their answers; this ensured discussions among the farmers.

Table D - 2: An overview of interviewed stakeholders.

Stakeholder	Position	Type	How many people	Date
Getas farming community	Farmers	FGD	6	23 January 2019
Pitu farming community	Farmers	FGD	6	19 January 2019
Bappeda Ngawi	Heads of planning and agricultural department	Interviews	7	18 January 2019
Bappeda Blora	Heads of planning and agricultural department	Interviews	2	14 January 2019
Perum Perhutani	Heads of planning department	Interviews	3	21 January 2019

Watershed Office	Head and staff of evaluation department	Interviews	4	4-6 February 2019
UGM	Dean, vice dean, 2 lecturers	Interviews	4	1-5 March 2019

Matrix of collected data

The data collected from all respondents is put into a matrix, with statements as rows and respondents as columns. The cell values then are the score of the ranked statements. See Table D - 3 and Table D - 4: for an overview of the collected data.

Table D - 3: Overview of collected data.

Statement	FGDG	FGDP	BB1	BB2	BN1	BN2	BN3	BN4	BN5	BN6	BN7
1	2	1	2	2	2	-1	-1	-1	2	1	-2
2	-2	-1	-2	-2	-1	1	1	2	-2	-1	2
3	2	1	2	2	1	1	2	2	1	2	1
4	2	-2	2	1	1	1	1	2	1	2	2
5	2	2	2	0	1	-1	-1	-1	-1	-1	1
6	2	-1	2	2	1	1	-1	2	1	-1	2
7	2	0	2	2	2	1	2	2	1	2	1
8	1	1	2	2	2	1	2	2	2	1	1
9	1	2	2	2	2	1	1	2	2	2	2
10	-1	-2	-2	-2	-2	-1	-1	-1	-2	-1	-2
11	1	2	0	2	0	1	1	1	1	1	0
12	2	2	2	2	1	1	1	1	2	1	1
13	1	2	0	0	1	1	1	1	1	1	0
14	1	0	2	2	1	1	1	1	1	1	0
15	-1	-1	-2	-1	1	-2	-1	-1	2	-1	-1
16	2	0	-2	-2	1	-1	-1	0	1	1	0
17	2	2	2	-1	0	2	1	1	2	1	2

Table D - 4: Extended overview of collected data

Statement	PP1	PP2	PP3	WO1	WO2	WO3	WO4	UGM1	UGM2	UGM3	UGM4
1	2	-1	-1	1	2	-1	-1	-1	1	0	2
2	-1	1	2	-1	-2	-1	1	2	0	0	-2
3	2	2	2	2	2	1	1	2	2	1	2
4	1	1	1	1	-2	-2	1	-1	2	-1	2
5	-2	-1	1	-2	-2	0	-1	-1	-1	1	1
6	2	1	-1	2	2	1	-1	1	2	1	2
7	2	1	1	2	2	2	1	2	2	2	2
8	2	1	1	2	2	1	-1	2	1	1	2
9	2	1	1	2	2	1	-1	2	2	1	2
10	-2	-1	-1	-1	-2	-1	-1	-2	-2	-2	-2
11	2	1	1	2	2	1	1	2	1	2	2
12	2	1	1	2	2	1	1	2	2	1	2
13	1	-1	1	0	-2	0	0	2	0	0	0
14	2	1	0	1	2	1	1	2	2	2	2
15	-1	-1	1	-2	-2	-1	-1	-2	-1	-2	-2
16	-2	-1	-1	-1	-2	-1	-1	-2	-1	-1	2
17	2	1	-1	2	2	1	1	2	-2	2	2

D.3.Analysis

Number of perceptions

The extracted perceptions summarize all individual responses into a few representative responses. The criteria used to choose the number of perceptions to extract vary across studies, but most studies consider two or more criteria (Zabala et al., 2018). For this study the following criteria are applied:

- The selected perceptions must have an eigen value greater than 1 (Saigal et al., 2005).
- The number of Q sorts determining each perception (Raadgever et al., 2008a; Seyni et al., 2018)
- The total amount of variability explained (Zabala et al., 2018)

These criteria are approximate indicators of the strength of each perception and of the proportion of the opinions they explain. See Table D - 5 for the results of the criteria for two, three, and four perceptions.

Table D - 5: Criteria results for different number of perceptions; P1 refers to the first perception, P2 to the second perception, etc.

	2 perceptions			**3 perceptions**			**4 perceptions**		
	Eigen value	**Q sorts**	**Variability (%)**	**Eigen value**	**Q sorts**	**Variability (%)**	**Eigen value**	**Q sorts**	**Variability (%)**
P1	7.9	14	35.9	6.5	8	29.6	7.3	7	33.3
P2	7.1	8	32.2	6.3	9	28.5	6.8	9	31.0
P3	x	x	x	3.8	4	17.1	2.1	1	9.7
P4	x	x	x	x	x	x	1.5	1	6.8
		22	68.1		21	75.2		18	80.8

For every number of perceptions, the eigen value is greater than one. However, when extracting four perceptions, there are perceptions with only one determining Q sort. Although the explained variability increases with extracting four perceptions, it is necessary to have more than one Q sort determining a perception. Comparing two or three perceptions shows that both have favourable results for the criteria. Extracting three perceptions results in one Q sort that does not belong to any of the perceptions. Extracting three perceptions, however, explains a bigger fraction of the variability. Thus, three perceptions will be extracted in this analysis.

Non-forced distribution and perception scores

As mentioned in the previous section on the data collection, a non-forced distribution is applied. Therefore, when applying the qmethod function, the argument forced should be FALSE and a vector must be provided in the argument distribution. This vector contains as many entries as the number of statements (17) and it is the array of values corresponding to the grid. However, since the participants did not have to follow a grid, it is illogical to now create a distribution according to the average scores of the statements. This array is only used to obtain the perception scores, while all other calculations, such as the z-scores and the significant differences between statements remain unaffected.

Perception (integer) scores indicate how a hypothetical person representing a group of similar respondents would rank the statements. The perception scores are assigned by ranking all statements by their z-scores, and then allocating the scores present in the distribution grid, in order. E.g. the statement with the lowest z-score will get a perception score of -2, and so on. Zabala recommends focussing the interpretation mainly on the z-scores, rather than on the perception scores in cases where the distribution is non-forced (A. Zabala, personal communication, February 26, 2019). Thus, the perception scores will not be analysed and used for interpretation in this thesis, since they are unreliable.

General characteristics

Table D - 6 gives an overview of the general characteristics of the Qmethod analysis.

Table D - 6: General characteristics of the Q analysis.

	Number of Q sorts	Eigen value	Explained variability (%)	Reliability
Perception A	8	6.5	29.6	0.97
Perception B	9	6.3	28.5	0.97
Perception C	4	3.8	17.1	0.94

The number of Q sorts that are represented in each perception indicate that the distribution of perceptions amongst the stakeholders is roughly equal. Next, the eigen values are significantly greater than one, indicating that the perceptions explain more of the total variance than a single Q sort. Moreover, Q aims to explain as much of the variability among the observed Q sorts as possible, since this indicates the strength of each perception and of the proportion of opinion they explain. This Q analysis has an explained variance of 75.2%. A study reviewing 52 Q studies in conservation contexts has revealed that the average explained variability by all perceptions is 59% (Zabala et al., 2018). Thus, this suggests the comprehensiveness of the results in explaining the perceptions of the stakeholders based on these three perceptions. Next, the more respondents defining a perception, the higher the reliability of that perception. The reliability of all three perceptions is relatively high.

Flagging of Q sorts

Table 7 in chapter 3.4 presents the relation between each respondent and perception. The higher a respondent's loading on a perception, the more representative she is of that perception. This loading is used to assign each perception to a respondent. Table D - 7 gives an overview of this flagging.

Table D - 7: Overview of flagged Q sorts; perception A, B, and C stand for the three perceptions.

	Perception A	Perception B	Perception C
Getas community	FALSE	TRUE	FALSE
Pitu community	FALSE	FALSE	TRUE
Bappeda Blora 1	FALSE	TRUE	FALSE
Bappeda Blora 2	FALSE	TRUE	FALSE
Bappeda Ngawi 1	FALSE	TRUE	FALSE
Bappeda Ngawi 2	TRUE	FALSE	FALSE
Bappeda Ngawi 3	TRUE	FALSE	FALSE
Bappeda Ngawi 4	TRUE	FALSE	FALSE
Bappeda Ngawi 5	FALSE	TRUE	FALSE
Bappeda Ngawi 6	FALSE	TRUE	FALSE
Bappeda Ngawi 7	TRUE	FALSE	FALSE
Perhutani 1	FALSE	TRUE	FALSE
Perhutani 2	TRUE	FALSE	FALSE
Perhutani 3	TRUE	FALSE	FALSE
Watershed 1	FALSE	FALSE	FALSE
Watershed 2	FALSE	FALSE	TRUE
Watershed 3	FALSE	FALSE	TRUE
Watershed 4	TRUE	FALSE	FALSE
UGM 1	TRUE	FALSE	FALSE
UGM 2	FALSE	TRUE	FALSE
UGM 3	FALSE	FALSE	TRUE
UGM 4	FALSE	TRUE	FALSE

The scores of statements for each perception

The z-scores indicate the relationship between statements and perceptions. It is a weighted average of the scores given by the flagged Q sorts to that statement. Table D - 8 presents the z-scores.

Table D - 8: The z-scores of the statements, presented in order of the statements.

Statement	Perception A	Perception B	Perception C
The water use of an agroforestry system is higher than the water use of a monocropping system	-1.53	0.87	-0.07
Monocropping systems demand more water than agroforestry systems	0.89	-1.98	-1
Increasing the number of trees improves the water availability at a regional scale	1.15	0.71	0.65
The roots of the trees soak in water during the rainy season, and release the water during the dry season	0.55	0.54	-1.66
Trees are consumers of available water and are competitors for other water users (such as crops)	-1.22	-0.46	0.01
Trees reduce the surface runoff of water in farming lands	0.13	0.52	0.3
Are you interested in understanding how different farming practices affect the water use of the farming lands?	0.92	0.91	0.97
Are you interested in understanding how agroforestry systems and monoculture systems affect the water use of the farming lands differently?	0.75	0.79	0.65
I believe that agroforestry systems and monocropping systems are different in their water use	0.66	0.92	0.82
In my opinion, all farming systems (agroforestry and monocropping) have a similar water demand for their farming lands	-1.62	-2.3	-1.7
In my opinion, agroforestry systems are a reliable tool for soil and water conservation on farming lands	0.49	0.15	1.08
I believe agroforestry systems reduce the risks of floods	0.56	0.74	0.82
In this area, there are mostly monocropping systems (compared to agroforestry systems)	0.07	-0.23	-0.26
We try/encourage farmers to include trees on the farming lands	0.43	0.57	0.74
I prefer monocropping systems compared to agroforestry systems since trees use too much water	-1.57	-1.08	-1.53
When applying agroforestry, I worry about the competition between trees and crops for available soil water	-1.29	-0.57	-0.92
I apply/We encourage farmers to apply agroforestry for soil and water conservation of the farming lands	0.63	-0.09	1.08

Table D - 8 shows that, overall, there is more agreement than disagreement. However, the level of agreement in all perceptions is not very confident, with variations between 0.01 to 1.15. Meanwhile, the level of disagreement shows more confidence with variations between -0.07 to -2.3. This score of -2.3 is possible because the z-scores are a weighted average of scores given by the corresponding Q sorts. See chapter 3 for the perceptions in which the z-scores of the statements are elaborately explored and compared.

Consensus and distinguishing statements

The z-scores can be used to identify consensus and distinguishing statements. The comparison of absolute differences between perception z-scores indicate whether a statement is consensus or distinguishing. See Table D - 9 for the standard error of differences with their statistical significance.

Table D - 9: Standard error of differences and their statistical significance; 'PA-PB' shows the absolute difference in z-scores between perception A and B.

Statement	Consensus or distinguishing	PA – PB	Significance PA – PB	PA – PC	Significance PA – PC	PB – PC	Significance PB – PC
1	Distinguishes all	-2.40	****	-1.46	****	0.93	**
2	Distinguishes all	2.87	****	1.89	****	-0.98	***
3	Consensus	0.44		0.50		0.06	
4	Distinguishes f3 only	0.01		2.21	****	2.20	****
5	Distinguishes f1 only	-0.76	**	-1.23	***	-0.47	
6	Consensus	-0.39		-0.18		0.22	
7	Consensus	0.02		-0.04		-0.06	
8	Consensus	-0.03		0.10		0.14	
9	Consensus	-0.26		-0.16		0.10	
10	Distinguishes f2 only	0.68	**	0.07		-0.60	*
11	Distinguishes f3 only	0.34		-0.59	*	-0.94	**
12	Consensus	-0.19		-0.27		-0.08	
13	Consensus	0.29		0.32		0.03	
14	Consensus	-0.13		-0.31		-0.17	
15	Neither	-0.48	*	-0.04		0.44	
16	Neither	-0.72	**	-0.37		0.35	
17	Distinguishes f2 only	0.72	**	-0.46		-1.18	***

Differences that are significantly different at a p-value < 0.05 are indicated with '*', differences significant at a p-value < 0.01 with '**', differences significant at p-value < 0.001 with '***', and differences significant at p-value < 0.000001 with '****'. Then, there are several categories for the statements:

- When all the comparisons between each pair of perceptions are significantly different the statement is labelled as 'distinguishes all'.
- When the comparisons of perception x with all other perceptions are significant different and comparisons between all other perceptions are not significant, the statement is labelled as 'distinguishes perception x'.
- When none of the comparisons are significantly different because all perceptions give the statement a similar score, the statement is labelled as 'consensus'.
- Statements that are labelled 'neither' are neither consensus nor clearly distinguishing for any of the perceptions in particular.

Table D - 10 shows the correlation between perception z-scores. The relatively high values indicate that there is a high similarity (i.e. consensus) between the different perceptions.

Table D - 10: Correlation between perception z-scores.

	Perception A	Perception B	Perception C
Perception A	1	0.47	0.58
Perception B	0.47	1	0.69
Perception C	0.58	0.69	1

Appendix E: Perception FGD and interview format

This appendix presents the FGD and interview formats. The formats are almost identical. However, the FGD format presents the statements from a farmer viewpoint (so the farmer answers the question for his farming area). The interview format on the other hand presents the statements for the Getas and Pitu area together (so more in a manager perspective).

E.1. FGD format

Date: ____________________________

Name: ____

Location: ____

My name is Rhodé and I am a student from the Netherlands. I am doing my bachelor thesis at the Gadjah Mada University. I want to investigate the perceptions of different stakeholders on the effects of different farming systems on the water use of their farming lands. This project focuses on Getas and Pitu. I hope you are willing to participate in this interview.

Nama saya Rhodé dan saya seorang pelajar dari Belanda. Saya sedang melakukan penelitian sarjana saya di Universitas Gadjah Mada. Saya ingin menliti persepsi para pemangku kepentingan yang berbeda tentang efek dari sistem pertanian yang berbeda pada penggunaan air lahan pertanian mereka. Penelitian ini berfokus di Desa Getas dan Pitu. Saya berharap Anda bersedia untuk berpartisipasi dalam wawancara ini.

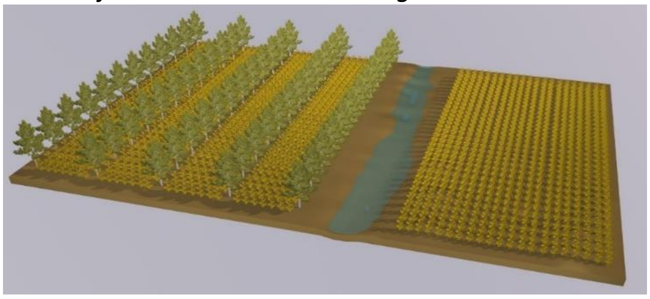
Explanation of terms / penjelasan istilah

Agroforestry systems: a land use system in which trees, shrubs, etc are grown together with agricultural crops.

> *Sistem agroforestry (wanatani): sistem penggunaan lahan di mana pohon, semak, dll ditanam bersama dengan tanaman pertanian.*

Monocropping systems: a land use system that grows only crops on a piece of land.

> *Sistem monocropping/monokultur: sistem penggunaan lahan yang hanya menanam satu jenis tanaman di sebidang tanah.*



Water use includes the water demand and water consumption of a system. It describes the amount of water the farming lands use.

> *Penggunaan air mencakup permintaan air dan konsumsi air dari suatu sistem. Ini menggambarkan jumlah air yang digunakanpada lahan pertanian.*

The following questions will consist of statements and open questions. State your level of agreement with the statements by choosing / *Pertanyaan-pertanyaan berikut akan terdiri dari pernyataan dan pertanyaan terbuka. Nyatakan tingkat persetujuan Anda dengan pernyataan dengan memilih*:

+ +	Fully agree	*Sangat setuju*
+	Agree	*Setuju*
?	Don't know or neutral	*Tidak tahu atau netral*
-	Disagree	*Tidak setuju*
- -	Strongly disagree	*Sangat tidak setuju*

Knowledge / Pengetahuan

1. **The water use of an agroforestry system is higher than the water use of a monocropping system / *Penggunaan air dari sistem agroforestri lebih tinggi daripada penggunaan air dari sistem monokultur***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

2. **Monocropping systems demand more water than agroforestry systems / *Sistem monokultur membutuhkan lebih banyak air daripada sistem agroforestri***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

3. **Increasing the number of trees improves the water availability at a regional scale / *Meningkatkan jumlah pohon akan memperbaiki ketersediaan air pada skala regional***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

4. **The roots of the trees soak in water during the rainy season, and release the water during the dry season / *Akar pohon terendam di air selama musim hujan, dan melepaskan air selama musim kemarau***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

5. **Trees are consumers of available water and are competitors for other water users (such as crops) / *Pohon merupakon konsumen air yang tersedia dan merupakan pesaing bagi pengguna air lainnya (seperti tanaman)***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

6. **Trees reduce the surface runoff of water in farming lands / *Pohon mengurangi limpasan air permukaan air di lahan pertanian***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

Attitudes / *Sikap*

1. **Are you interested in understanding how different farming practices affect the water use of the farming lands? / *Apakah Anda tertarik untuk memahami bagaimana praktik pertanian yang berbeda dapar mempengaruhi penggunaan air di lahan pertanian?***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

2. **Are you interested in understanding how agroforestry systems and monoculture systems affect the water use of the farming lands differently? / *Apakah Anda tertarik untuk memahami bagaimana sistem agroforestri dan sistem monokultur mempengaruhi penggunaan air lahan pertanian secara berbeda?***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
____
____

3. **I believe that agroforestry systems and monocropping systems are different in their water use / *Saya percaya bahwa system agroforestri dan sistem monokultur berbeda dalam penggunaan airnya***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
____
____

4. **In my opinion, all farming systems (agroforestry and monocropping) have a similar water demand for their farming lands / *Menurut pendapat saya, semua sistem pertanian (agroforestri dan monokultur) memiliki kebutuhan air yang sama untuk lahan pertanian mereka***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
____
____

5. **In my opinion, agroforestry systems are a reliable tool for soil and water conservation on farming lands / *Menurut saya, sistem wanatani adalah sistem yang baik untuk konservasi tanah dan air di lahan pertanian***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
____
____

6. **I believe agroforestry systems reduce the risks of floods / *Saya percaya sistem wanatani depat mengurangi risiko banjir***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
____
____

Practices / *Praktek*

1. **In this area, there are mostly monocropping systems (compared to agroforestry systems) / *Di daerah ini, sebagian besar menggunatan sistem monokultur (dibandingkan dengan sistem agroforestri)***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
____
____

2. **We try to include trees on the farming lands / *Kami mencoba untuk memasukkan pohon di lahan pertanian***
☐ + + ☐ + ☐ ? ☐ - ☐ - -
Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

____

____

3. **I prefer monocropping systems compared to agroforestry systems since trees use too much water / *Saya lebih suka sistem monokultur dibandingkan sistem agroforestri karena pohon terlalu banyak menggunakan air***
   ☐ + + ☐ + ☐ ? ☐ - ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
   ____
   ____

4. **When applying agroforestry, I worry about the competition between trees and crops for available soil water / *Saat menerapkan wanatani, saya khawatir tentang persaingan antara pohon dan tanaman untuk ketersediaan air tanah***
   ☐ + + ☐ + ☐ ? ☐ - ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
   ____
   ____

5. **I apply agroforestry for soil and water conservation of the farming lands / *Saya menerapkan agroforestri untuk konservasi tanah dan air di lahan pertanian***
   ☐ + + ☐ + ☐ ? ☐ - ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*
   ____
   ____

Thank you very much for your time!
Terima kasih banyak atas waktunya!

E.2. Interview format

Date: ____________________________

Name: ____

Office: ____

Location: ____

My name is Rhodé and I am a student from the Netherlands. I am doing my bachelor thesis at the Gadjah Mada University. I want to investigate the perceptions of different stakeholders on the effects of different farming systems on the water use of their farming lands. This project focuses on Getas and Pitu. I hope you are willing to participate in this interview.

Nama saya Rhodé dan saya seorang pelajar dari Belanda. Saya sedang melakukan penelitian sarjana saya di Universitas Gadjah Mada. Saya ingin menliti persepsi para pemangku kepentingan yang berbeda tentang efek dari sistem pertanian yang berbeda pada penggunaan air lahan pertanian mereka. Penelitian ini berfokus di Desa Getas dan Pitu. Saya berharap Anda bersedia untuk berpartisipasi dalam wawancara ini.

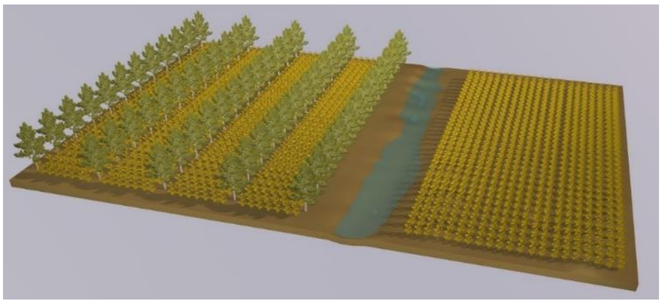
Explanation of terms / *penjelasan istilah*

<u>Agroforestry systems:</u> a land use system in which trees, shrubs, etc are grown together with agricultural crops.

> *<u>Sistem agroforestry (wanatani)</u>: sistem penggunaan lahan di mana pohon, semak, dll ditanam bersama dengan tanaman pertanian.*

<u>Monocropping systems:</u> a land use system that grows only crops on a piece of land.

> *<u>Sistem monocropping/monokultur</u>: sistem penggunaan lahan yang hanya menanam satu jenis tanaman di sebidang tanah.*



<u>Water use</u> includes the water demand and water consumption of a system. It describes the amount of water the farming lands use.

> *<u>Penggunaan air</u> mencakup permintaan air dan konsumsi air dari suatu sistem. Ini menggambarkan jumlah air yang digunakanpada lahan pertanian.*

The following questions will consist of statements and open questions. State your level of agreement with the statements by choosing / *Pertanyaan-pertanyaan berikut akan terdiri dari pernyataan dan pertanyaan terbuka. Nyatakan tingkat persetujuan Anda dengan pernyataan dengan memilih*:

+ +	Fully agree	*Sangat setuju*
+	Agree	*Setuju*
?	Don't know or neutral	*Tidak tahu atau netral*
-	Disagree	*Tidak setuju*
- -	Strongly disagree	*Sangat tidak setuju*

Knowledge / Pengetahuan

1. **The water use of an agroforestry system is higher than the water use of a monocropping system / *Penggunaan air dari sistem agroforestri lebih tinggi daripada penggunaan air dari sistem monokultur***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

2. **Monocropping systems demand more water than agroforestry systems / *Sistem monokultur membutuhkan lebih banyak air daripada sistem agroforestri***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

3. **Increasing the number of trees improves the water availability at a regional scale / *Meningkatkan jumlah pohon akan memperbaiki ketersediaan air pada skala regional***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

4. **The roots of the trees soak in water during the rainy season, and release the water during the dry season / *Akar pohon terendam air selama musim hujan, dan melepaskan air selama musim kemarau***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

5. **Trees are consumers of available water and are competitors for other water users (such as crops) / *Pohon merupakon konsumen air yang tersedia dan merupakan pesaing bagi pengguna air lainnya (seperti tanaman)***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

6. **Trees reduce the surface runoff of water in farming lands / *Pohon mengurangi limpasan air permukaan air di lahan pertanian***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

Attitudes / Sikap

1. **Are you interested in understanding how different farming practices affect the water use of farming lands in Getas and Pitu? / *Apakah Anda tertarik untuk memahami bagaimana praktik pertanian yang berbeda dapar mempengaruhi penggunaan air tanah pertanian di Getas dan Pitu?***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

2. **Are you interested in understanding how agroforestry systems and monoculture systems affect the water use of farming lands differently? / *Apakah Anda tertarik untuk memahami bagaimana sistem agroforestri dan sistem monokultur mempengaruhi penggunaan air lahan pertanian secara berbeda?***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

3. **I believe that agroforestry systems and monocropping systems are different in their water use / *Saya percaya bahwa sistem agroforestri dan sistem monokultur berbeda dalam penggunaan airnya***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

4. **In my opinion, all farming systems (agroforestry and monocropping) have a similar water demand for their farming lands / *Menurut pendapat saya, semua sistem pertanian (agroforestri dan monokultur) memiliki kebutuhan air yang sama untuk lahan pertanian mereka***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

5. **In my opinion, agroforestry systems are a reliable tool for soil and water conservation on farming lands / *Menurut saya, sistem wanatani adalah sistem yang baik untuk konservasi tanah dan air di lahan pertanian***

   ☐ + + ☐ + ☐ ? ☐ - ☐ - -

Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

____

____

6. **I believe agroforestry systems reduce the risks of floods / *Saya percaya sistem wanatani dapat mengurangi risiko banjir***
   ☐ + +   ☐ +   ☐ ?   ☐ -   ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

Practices / Praktek

1. **In this area, there are mostly monocropping systems (compared to agroforestry systems) / *Di daerah ini, sebagian besar memggunatan sistem monokultur (dibandingkan dengan sistem agroforestri)***
   ☐ + +   ☐ +   ☐ ?   ☐ -   ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

2. **We try to encourage farmers to include trees on the farming lands / *Kami mencoba mendorong petani untuk memasukkan pohon di lahan pertanian***
   ☐ + +   ☐ +   ☐ ?   ☐ -   ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

3. **We prefer monocropping systems compared to agroforestry systems since trees use too much water / *Kami lebih memilih sistem monokultur dibandingkan dengan sistem agroforestri karena pohon terlalu banyak menggunakan air***
   ☐ + +   ☐ +   ☐ ?   ☐ -   ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

4. **When agroforestry systems are applied, we worry about the competition between trees and crops for available soil water / *Ketika sistem agroforestri diterapkan, kami khawatir tentang persaingan antara pohon dan tanaman untuk ketersediaan air tanah***
   ☐ + +   ☐ +   ☐ ?   ☐ -   ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

5. **We encourage farmers to apply agroforestry for soil and water conservation of the farming lands / *Kami mendorong petani untuk menerapkan agroforestri untuk konservasi tanah dan air di lahan pertanian***
   ☐ + +   ☐ +   ☐ ?   ☐ -   ☐ - -
   Why did you choose this option? / *Mengapa Anda memilih opsi ini?*

   ____

   ____

Thank you very much for your time!
Terima kasih banyak atas waktunya!

Appendix F: Qmethod script

```
# This script performs the Q analysis using the package Qmethod. First, the data is imported.
# Next, the number of perceptions to extract is decided, and the rotation method is chosen.
# The following step consists of a final run of the analysis and exploring the results of the analysis.
# Finally, the results are exported to investigate them thoroughly for an interpretation.

# Load package
library(qmethod)

# Set directory path
setwd("C:/Users/Rhodé Rijneveld/Google Drive/0Rhodé/Universiteit/Year 3/MOD11_Bachelor_Thesis/QMETHOD")

#DATA IMPORT AND CHECK====================================================
# Import data into R from CSV-file
mydata <- read.csv('qsorts.csv', header = TRUE,row.names = 1)
# Check that data is correctly imported
#   See the number of statements and of Q-sorts:
dim(mydata)
#   See the whole dataset:
mydata

#EXPLORE CORRELATIONS BETWEEN Q-SORTS=====================================
# Here you could choose the correlation method from either: Pearson,
# Kendall or Spearman (Pearson being the default option).
# See the help page for the function cor() for more details.
cor(mydata)

#THE ANALYTICAL DECISIONS==============================================
# respondents do not have to follow a forced distribution grid when sorting the statements.
# Create a vector with the scores of the expected distribution. The distribution vector is only used for perception scores,
# and it does not influence other outcomes. The perception scores will not be used (see Appendix D.3), so the elements in this vector
# do not matter.The vector is only neccesary for the analysis to recognize that it is a non-forced distribution.
distro <- c(-2,-2,-2,-2, -1,-1,-1,-1, 0, 1,1,1,1, 2,2,2,2)

# qmethod automatically applies varimax rotation
results <- qmethod(mydata, nfactors = 4, forced = FALSE, distribution = distro)

# Decide upon the number of perceptions to extract
results$f_char$characteristics
# Column 'eigenvals': eigenvalues
# Column 'expl_var':  percentage of explained variability
```

```
# Column 'nload':     number of Q-sorts flagged

#RUN THE FINAL ANALYSIS===================================================
#Once the final number of perceptions has been decided, run the analysis again.
#The method below uses 'varimax' rotation and Pearson coefficient for the initial correlation by default
results <- qmethod(mydata, nfactors = 3,
            forced = FALSE,
            distribution = distro)

#EXPLORE THE RESULTS=====================================================
#1.   General characteristics
results$f_char$characteristics

#2.   The perception loadings
# The relation between each respondent and perception
round(results$loa, digits = 2)

# The flagged Q-sorts; the perception that belongs to a respondent
results$flag


#3.   Item scores
# Overview of z-scores - relation between each statement and each perception
results$zsc

# Plot the z-scores for statements. Statements are sorted from highest consensus (bottom) to highest disagreement (top).
# dist = true, so the distinguising statements are filled in
plot(results, dist = TRUE)

# matrix of correlation between perception z scores
results$f_char$cor_zsc

# matrix of standard error of differences between perceptions
results$f_char$sd_dif

#4.   Explore the distinguishing and consensus statements
# Full table
results$qdc

# Consensus statements
results$qdc[which(results$qdc$dist.and.cons == "Consensus"), ]

# Statements distinguishing all perceptions
```

```
results$qdc[which(results$qdc$dist.and.cons == "Distinguishes all"), ]

# Statements distinguishing perception 1 (for results of > 2 perceptions)
results$qdc[which(results$qdc$dist.and.cons == "Distinguishes f1 only"), ]

results$qdc[which(results$qdc$dist.and.cons == "Distinguishes f2 only"), ]

results$qdc[which(results$qdc$dist.and.cons == "Distinguishes f3 only"), ]


#EXPORT THE RESULTS=====================================================
# Export results into spreadsheets or text file

#1. Table of general characteristics:
write.csv(results$f_char$characteristics,   file = "1 general characteristcs.csv")

#2. Table of Q-sort perception loadings:
write.csv(results$loa,   file = "2.1 factor loadings.csv")
#2. Table of flagged Q sorts:
write.csv(results$flag,   file = "2.2 flagged Qsorts.csv")

#3. Table of z-scores:
write.csv(results$zsc,   file = "3.1 zscores.csv")

# matrix of correlation between perception z scores
write.csv(results$f_char$cor_zsc, file = "3.2 correlation zscores.csv")

# matrix of standard error of differences between perceptions
write.csv(results$f_char$sd_dif, file = "3.3 standard error of differences.csv")

#4. Consensus and distinguishing statements
write.csv(results$qdc, file = "4.1 all statements.csv")
write.csv(results$qdc[which(results$qdc$dist.and.cons == "Consensus"), ], file = "4.2 consensus.csv")
write.csv(results$qdc[which(results$qdc$dist.and.cons == "Distinguishes all"), ], file = "4.3 dist all.csv")
write.csv(results$qdc[which(results$qdc$dist.and.cons == "Distinguishes f1 only"), ], file = "4.4 Dist F1 only.csv")
write.csv(results$qdc[which(results$qdc$dist.and.cons == "Distinguishes f2 only"), ], file = "4.5 Dist F2 only.csv")
write.csv(results$qdc[which(results$qdc$dist.and.cons == "Distinguishes f3 only"), ], file = "4.6 Dist F3 only.csv")

# text files
export.qm(results, file = "myreport.txt", style = "R")
```