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Perceptions of Change: Adopting the Concept of Livelihood Styles for a More Inclusive Approach to ‘Building with Nature’

Edwin B. P. de Jong * and Kimberly Kuipers 

Department of Anthropology and Development Studies, Radboud University Nijmegen,
6500 HE Nijmegen, The Netherlands; kimberlykuipers@live.nl

* Correspondence: e.dejong@maw.ru.nl; Tel.: +31-24-361-3058/9

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Abstract: The world’s wetlands are threatened by deforestation, fires, agriculture, mining, overfishing, and human settlement. While policymakers strive for comprehensive technical solutions, sustainable solutions also require the active engagement of the people affected. To mobilize local human action, it is not enough to investigate the facts and figures of the biophysical natural landscape: we also need a better understanding of how local people perceive these changes. In this article, we adopt the concept of livelihood styles to explain the ways in which people construe a perspective of their aquatic environment with which they continuously, and according to a certain pattern, interact to make a living. Our study is based on a mixed-method study with data collected between 2005 and 2015 in the Mahakam Wetlands of Indonesian Borneo (Kalimantan). We found five distinct livelihood styles: investors, boatmen, breeders, traditional fishermen, and “indolent” fishermen, that each possess characteristics related to fishing practices, and found significant differences in their perceptions of water quality changes. As such, we demonstrate that perceptions and patterns of practice are interdependently related. Understanding perceptions through a livelihood styles approach provides an opening for policymakers to build with local people and nature towards a sustainable environment, both in Indonesia and beyond.

Keywords: livelihood (styles); sustainable development; perceptions; natural resources; wetlands; water pollution; deforestation; Indonesia

1. Introduction

Wetlands are essential systems—the arteries and veins of the ecosystem. They are critical to humans and the natural environment, acting as water sources and purifiers, and providing almost all the world’s consumption of fresh water, making them one of the world’s most valuable ecosystems. Yet, with a loss of approximately 35% between 1970 and 2015, wetlands are disappearing three times faster than forests [1]. The Global Wetland Outlook of the Ramsar Convention on Wetlands [1] states that wetlands contribute to 75 of the Sustainable Development Goals’ (SDGs) indicators. As such, the rapid contraction of wetlands has severe consequences for achieving the SDGs.

Wetlands are often undervalued by policymakers and decision-makers in national plans. When they do come into focus, plans and policies are usually based on a comprehensive technical approach that uses ecological processes to achieve sustainability. Generally, these ignore various actors with a stake in the development of the wetlands, especially local populations. An example of this is the Indonesian “building with nature” project that seeks innovative infrastructure solutions to enhance coastal security, with the idea of mainstreaming this pilot project to all types of water bodies in the archipelago.

However, many authors, for example [2,3], argue that one needs to understand regions and communities as social-ecological systems, in which people depend on resources and services provided by the ecosystems, while these ecosystems' dynamics are also influenced, to varying degrees, by human activities, creating an interdependency. Sustainable solutions thus require active engagement with the groups of people affected by policy decisions (as well as other stakeholders) who must live with, and participate in, the implementation of potential solutions [4] (p. 26). In other words, with appropriate stewardship, this human capacity can be mobilized to repair and, more importantly, enhance the capacity of the ecological system to support sustainable societal development in the longer term.

To be able to mobilize local human action, it is not sufficient to investigate the facts and figures of the biophysical nature, such as changes in water quality and quantity: we also need a better understanding of the way people perceive these changes. Previous research in the Middle Mahakam Wetlands, located in Indonesian Borneo, for example, has shown discrepancies between people's perceptions and the biophysical changes that have been taking place in recent decades (for more information, see [5]), illustrating that the same objects in the same physical surroundings can mean quite different things to individuals who belong to the same community [6] (p. 36). When people act in relationship with these objects, or have them in mind, their actions respond to the way they have already been appropriated, categorized, or valorized in terms of a particular pre-existing design, which we label as a livelihood style.

In other words, the "really natural" nature is perceived and interpreted differently by individual agents through their various dialectical ways of interacting with nature on the one hand, and the way these acts are shaped by wider social and cultural patterns or structures on the other. The aim of this article is to obtain better insight into the ways livelihood practices shape people's perspectives on environmental changes. In order to mobilize human action, it is important to identify the types of people that could function as "change agents"—the "motor" behind processes towards sustainable development—and can assist in an approach "to build with local people and the actually natural nature" towards a sustainable environment.

Patterns of acts, or routinized practices, are critical to management because they imply that human actions today, whether constructive or destructive, can influence the future state of the environment. The perceptions that humans have of the biophysical environment and their capacity to make choices that affect it (their agency) thus depend on both past interactions with the environment, and their experiences from these, and the social and cultural systems that they are part of. It is on this basis that Kofinas and Chapin [7] (p. 55) argue that livelihoods, which are the products of these interactions, "are a key element that sets the stage for sustainability, resilience, and adaptability of people for change."

In this article, we propose adopting the concept of livelihood styles as lived, habitus-forming entities to understand the way people construe a perspective of the world around them, including the aquatic environment with which they continuously, and according to a certain pattern, interact to make a living. As such, livelihood styles are an active expression of not only the relationship between the individual and society, between agency and structure, but also people's dialectical relationship with environmental change. To find out more about this relationship and the potential role of livelihoods, both as a means and as an end, we have constructed the following research question: to what extent can the different perspectives of people in the Middle Mahakam Wetlands on water quality change be explained using the concept of livelihood styles?

The degradation of Indonesia's wetlands is continuing at a rapid pace, and the Middle Mahakam Wetlands, located in the Indonesian part of Borneo, provide an excellent example of the various ways in which wetland ecosystems are increasingly threatened by a variety of factors including deforestation, forest fires, mining, and pollution [5,8] not only in Indonesia but far beyond. In 2008, the Global Nature Fund (GNF), an international foundation for the protection of the environment and nature, drew attention to the dramatic situation in various wetlands in Indonesia by proclaiming the lakes of the Middle Mahakam Wetlands to be the "Threatened Lakes of the year 2008" [9]. The envisaged relocation of Indonesia's capital to East Kalimantan further threatens the environment. While this

move is expected to relieve some of the environmental burden on the current capital Jakarta, the move to East Kalimantan will require the conversion of wetlands for farming and human settlements and the drainage of peatlands for water consumption [10].

Before we explore the livelihood styles in our case study villages in the Middle Mahakam wetlands and analyze whether and how these relate to the perspectives found on changes in water quality, we theorize further on the concept of livelihood styles in the following section.

2. Theoretical Framework

With a long-term dependency on, and experience with, their environments, local communities notice both minor and major changes in lake areas [11]. How they perceive changes is, according to Efron [12] (p. 137), based on past experiences, contemporary conditions, and future expectations. An individual's personal visions and beliefs can influence the way they act, meaning that the perceptions, perspectives, and visions of that individual influence their contemporary practices. Contrarily, practices are both the product of and the frame for people's perspectives. Varela, Rosch, and Thompson [13] argue that cognition, and thus perceptions based on it, is a result of a person's experiences as their actions continuously change the situations in which they are embedded. That is, a person's reference point is not the result of an autonomous mechanism dealing with information emanating from a world that is independent of perceptions [14] (p. 185). Rather, it is the combination of a person's perceptions that are constantly moderated by events in an environment, from which the person is not separate, that provide them with the opportunity to interact in various ways plus the recurrent patterns that enable action to be perceptually guided.

In line with this, Bourdieu [15] (p. 18) argues that perspectives depend on the point from which they are taken "since the vision that every agent has of the space depends on his or her position in that space." Building on these ideas, we accept the premise that perceptions and patterns of practices, or as we call them, "livelihood styles," are interdependently related. Below, we further elaborate on how we conceptualize livelihood styles.

The livelihoods perspective emerged in the 1980s and early 1990s as a reaction to the dominant narrow macroeconomic development approaches that focused largely on income, employment, and basic needs approaches to alleviating poverty, most notably [16–20]. The livelihoods perspective shifted the focus from structure to agency and emphasized the importance of social and cultural dimensions alongside material and economic aspects.

By emphasizing people's situated agency, or the way people "actively shape their lives in particular contexts through material and non-material assets" [21] (p. 53), it is logical to see livelihood practices as individual strategies. Agency-focused perspectives view people as pursuing rationally planned actions and trying to achieve predefined goals [21]. However, there is usually much more at stake than the deliberate motives or more conscious strategies of individuals. Consequently, several academics, notably [22–27], have put some extra "flesh on the bones" by emphasizing all kinds of issues, such as the complex linkages between access and capital, and including social and cultural dimensions. However, these attempts have not led to substantial changes in the frameworks used to study livelihoods, which are still centered on the "active role" that people play in responding to, and enforcing, change.

The practices of most people in the middle Mahakam Wetlands seem intrinsically bound to and determined by the social structures in which they are embedded. This is what Archer [28,29] refers to as the basic issue in contemporary social theory "the problem of structure and agency." According to Miles [30] (p. 19), "this point [the interface between agency and structure] is acutely evident at an everyday experiential level, where we see that life is actively constituted by the contrary feeling that the individual is both free and yet somehow simultaneously constrained."

In line with Miles, we propose bridging the debates on structure and agency by offering an alternative conceptual focus: "styles," or more specifically "livelihood styles." By employing the concept of style, it becomes possible to grasp people as agents in a social world [30]. More importantly, it helps when analyzing people's patterns of livelihood activities, not only as the outcome of strategically

planned actions for making a living, but also as the (unconscious as much as conscious) actions to protect existing or pursue new lifestyles and cultural identifications, and to fulfill their social obligations, in a dialectic relationship with the environment in which they are embedded. As Scoones [31] argues, to enhance the capacity of livelihood perspectives to address key lacunae, such as knowledge and sustainability, livelihood perspectives must look simultaneously at both structure and agency, and also at change, while remaining firmly rooted in place and context.

Although the concept of style is not entirely novel in the analysis of livelihoods, see for example [32,33], many of its dimensions are underexposed and lack a satisfactory explanation. In attempting to bridge the structure–agency divide, we build upon the ideas developed by De Jong [34] who established his approach by combining elements of both Giddens [35] and Bourdieu [36] (For a further elaboration on the concept of livelihood style see de Jong [34]).

Giddens' structuration theory [35] stresses the "duality of structure," meaning that actions and structure cannot be conceived separately and are two sides of the same coin. Giddens regards human actors (or agents) as the ultimate motor of structuration [37]: their reflexivity can change the routine of everyday practices, while their actions are given meaning in collective interpretive schemes. Against this background, Giddens [35] (p. 81) developed a notion of lifestyles. He defines a lifestyle as "a more or less integrated set of practices which an individual embraces, not only because such practices fulfil utilitarian needs, but because they give material form to a particular narrative of self-identity. (...) Lifestyles are [thus] routine practices, the routines incorporated into habits of dress, eating, modes of acting and favored milieu for encountering others; but the routines followed are reflexively open to change in the light of the mobile nature of self-identity." One should note that, in this explanation of lifestyles, the focus is still more on agency than structure.

Bourdieu [36,38], on the other hand, adopts a more structuralist position, albeit without losing sight of the agent. In Bourdieu's view, "position," "disposition" (habitus), and "position-taking" (practices) make up social space. A position is occupied by an actor on the basis of their occupation, education, or proximity to power. Positions are maintained and expressed to others through a process of position-taking. Positions and practices are linked together by the habitus, both a system of schemes of production of practices and a system of perception and appreciation of practices. The habitus (or disposition) of agents comprises "the mental structures through which they apprehend the social world" [16] (p. 18). It is on the basis of habitus that Bourdieu defines social groups (including social classes), "since those who occupy similar positions in the social structure will have the same habitus" [39] (p. 261). Following this logic, Bourdieu [40] (p. 172) defines lifestyles as "the systematic products of habitus": they are about behaving in a culturally acceptable way and are dependent on one's cultural capital.

Although this approach is useful in highlighting the importance of cultural factors in livelihood style analyses, there seems to be no conceptual (or empirical) space for the human agent, and the use of reflexivity is limited.

Despite the criticisms of both Giddens' and Bourdieu's studies of contemporary lifestyles, together they do cover most of the issues related to styles and the factors that shape them and, therefore, offer the fundamentals required to grasp the term when considering its usefulness in studying livelihoods.

Both authors start with human practices as their central focus of analysis and stress the routine or systematic nature of these practices, which are largely ordered in a pattern and hence show a certain unity. Both acknowledge that this pattern follows from the social context (or social space), social differentiation, and socioeconomic circumstances (or place) in which it is embedded. Further, they regard these patterns of practices as products of time, reflecting the ideas of de Haan and Zoomers [41] (p. 41), who argue that although the results may be the same, the pathways to get there might have been different.

Accordingly, on the basis of a synthesizing approach, de Jong [34] (p. 43) defines a livelihood style as: "a recognisable and coherent pattern of practices that results from an actor's conscious and unconscious objectives in establishing, maintaining, and enhancing a living in interaction (both in a

cooperative and conflicting manner) with other actors over time, and within the framework of status systems, cultural ideals and geographical space and place(s).” In this sense, livelihood styles can be perceived as a fairly stable set of objectively differentiated practices. However, how styles are perceived by the agents embodied in them (emic view) does not necessarily coincide with how they are perceived by those observing them (etic view).

It should be emphasized here that the term style does not imply that daily lives are homogenous. Rather, the key issue is that people have a wide range of options (in terms of resources, social relations, cultural repertoires, etc.) in a given context from which to establish a livelihood. Despite having options, particular livelihood styles, or clusters of livelihood styles, emerge as the outcome of the whole gamut of practices that are reflected in an impressive heterogeneity of daily lives [42] (p. 70). These patterns in livelihood practices exist because many people face similar inherited attributes (such as age, gender, ethnicity) and achieved attributes (e.g., educational level and political position) that provide them with similar opportunities and expectations. As these opportunities and expectations in establishing a livelihood are locally bounded, livelihood styles need to be understood in their local context [34] (p. 45).

The theoretical concept of livelihood styles outlined here will make much more sense when looking at concrete cases. In this study, we use the livelihood style concept to enhance understanding of the ways in which people in our two case study villages in the Middle Mahakam wetlands shape their lives as an expression of their continuing interactions with the environment. The first step is to differentiate the various livelihood styles in the two villages. Following this, these livelihood styles are further scrutinized to explain the different perceptions of the villagers of the ecological changes in their environment. As livelihood styles highlight people with similar perspectives and practices or, more specifically, similar ways of making a living in their particular environment, it is plausible that the ways in which people depend on this environment will shape their perceptions of local ecological changes. As such, looking at perceptions through the lens of livelihood styles, rather than individual or community characteristics, might provide a more convincing explanation of why villagers have different perceptions.

3. Site description

3.1. Middle Mahakam Wetlands

The Middle Mahakam wetlands are located in East Kalimantan, between 180 and 375 km upstream of the mouth of the Mahakam river. The area is traversed by the Mahakam river, which is 1–4 km wide in this area, and forms an important water catchment and control system for the natural regulation of the river. Covering an area of 18,000 km², the middle Mahakam wetlands, consisting of 3 major and roughly 32 minor lakes, constitute the largest freshwater system of East Kalimantan. The current study was limited to the three major lakes: Jempang (150 km²), Semayang (130 km²), and Melintang (110 km²), further referred to as the Middle Mahakam Lakes.

The Middle Mahakam Lakes have been increasingly threatened by various factors since the early 1980s. One of the major threats to the lakes is deforestation. In 2003, it was estimated that 66% of the East Kalimantan rainforest had disappeared in the previous 25 years [43]. The World Resource Institute [44] noted a 42% increase in forest loss in 2018 compared to the previous year, resulting in a total loss of 606,433 ha of rainforest in the region. This has reduced the capacity to absorb rainwater upstream of the Mahakam river, as well as increased levels of sedimentation in the lakes. In recent decades, flood levels have increased and water level fluctuations in the three major lakes can exceed six meters. At the same time, longer periods with high nutrient content in the water result in growing amounts of weeds. Further, the erosion of the reddish Kalimantan soil is likely to alter the acidity of the water.

One of the major reasons for deforestation increasing in both scale and frequency in recent decades is the occurrence of large fires [45]. The major driving forces for these fires are plantation development

by the government and companies [46,47] and the local community's use of fire in their agriculture and fishing activities (e.g., burning weed removed from the lakes to clear navigation routes) [48–50].

The large increase in agricultural activities, especially the development of oil palm plantations, poses another considerable threat to the area. This intensive form of agriculture depends on heavy use of agrochemicals (fertilizers and pesticides), which are a major source of eutrophication and pollution [51] (p. 72). Through runoff, subsurface flows, and periodic floods, the agrochemicals wash out into the rivers and streams feeding the lake area, affecting sedimentation, vegetation, fish stocks, and people's health. Furthermore, the application of agricultural fertilizers accelerates peat subsidence [52] (p. 665). In 2006, it was estimated by the United Nations Environment Programme that, in the area, over 100,000 ha were already being used for agriculture, coalmining, and oil-palm plantations. Four logging companies have concessions in the northern part of the lake area. Other concessions in the lake area are owned by three industrial forestry companies (rubber) and four oil palm plantation companies, mainly situated close to Lake Jempang.

There is a coalmining company south of Lake Jempang, alongside the Ohong river, that flows into Lake Jempang. The mining industry's waste (most prominently acidic debris and coal residues from open pit mining) washes off into the rivers, lakes, and swamps during heavy rainfall and increases the sulfur content of several chemical compounds found in the water.

Exotic invasive plant species, such as the widely spread water hyacinth, and new fish species have proved to be another threat to the wetlands. As Gopal [51] put it, "water hyacinth has become an agent of habitat destruction." The rapid increase in aquatic plants in the large lakes affects the water quality through the dead plant matter decomposing and also has other consequences for the habitat of white-fish species and eventually the more resilient black-fish species by reducing the water depth and flows in the lakes. Invasive fish species such as the predatory *toman* are also a threat to many of the primeval smaller fish types.

Finally, the growing human population also puts pressure on the limited resources in the area. Due to a large number of children and continuing immigration, the population has tripled during the past 20 years. This pressure leads to over-fishing that together with unsustainable fishing techniques such as electro-fishing, use of poison, and aquaculture, for which locals use various small fish species as food, threatens the reproduction rate of lake fish.

Water flows both in and out of these lakes to the River Mahakam and, as such, they function as aquifers by storing water during wet periods and slowly releasing this water back into the river when rainfall is low. There are a few significant freshwater tributaries that also flow into the lakes. For as long as anyone can recall, water levels in the lakes rise up to three meters for over a month in the rainy season but can drop to almost zero during the dry season. About one-third of the total area is temporarily flooded during the wet season. The lakes also function as very productive freshwater fisheries with many juvenile and larval fish, while the blackwater rivers that drain the swamps and enter the lakes yield predominantly white fish.

Nine villages are located on the edges of the three large lakes or at the mouths of the rivers that flow into them. The total population living in these villages is around 15,000 people. All but one village can be typified as a floating village in which the majority of the population live in floating houses. The populations of these floating villages are mostly of Kutai or Banjar origin, with a minority from Sulawesi (Bugis). The non-floating village, Tanjung Isuy, consists of a mixture of people from various ethnic backgrounds but with a majority with Dayak origins.

The primary source of livelihood for these "wetlander communities" is fishing. The fishermen catch a variety of fish throughout the year, with the species, catch, and locality dependent on the season. Finding particular fish requires specific skills and knowledge to locate the right time and spot (in the lake, river, or swamps). About 20 kinds of fishing gear are used, ranging from simple traditional longlines (*pancing* or *rawai*), fykes (long cylindrical nets, *pangilar*), and scoopnets (*jala*) to V-shaped dipnets (*ancau*), dragnets or trawling nets (*trol*), and electric shock devices (*strom*). Some equipment, such as the *trol* and *ancau*, are much more expensive than the *pancing* or *rawai*, which are usually

self-made from bamboo. The *rengge*, a large fishing net (about 30 m long) that hangs between two poles, is one of the most popular options. In some parts of the lakes, *rengge* are scattered all over the place. The volume of fish caught also depends on the number of motorboats (*ces*) and their type (6, 9, 16, or more horsepower) that people possess.

Additional fish are harvested from floating breeding cages (a form of aquaculture known locally as *keramba*). These *keramba* are wooden cages that should ideally be placed at locations that do not experience water quality changes (in terms of color, transparency, and contents) too frequently because this can stress the fish in the cages.

3.2. Case Study Villages

Data were collected in two typical fishing villages in the region, Muara Enggelam and Muara Ohong, referred to as Enggelam and Ohong (Figure 1). Enggelam is located on the edge of Lake Melintang and has a population of 624 people, distributed over 148 households, according to the 2006 statistics of BPS [53], mostly living in floating houses along both sides of the Enggelam river. Just over three-quarters of the population are ethnic Kutai, who have lived in this region for hundreds of years. Since the early 1900s, Banjarese migrants from South Kalimantan have moved to this area and now form around one-fifth of the population of Enggelam. There are also a few Buginese migrants from South Sulawesi, but these form a very small minority (1.1%). Although the Banjar are economically better off, the Kutai are still culturally dominant.

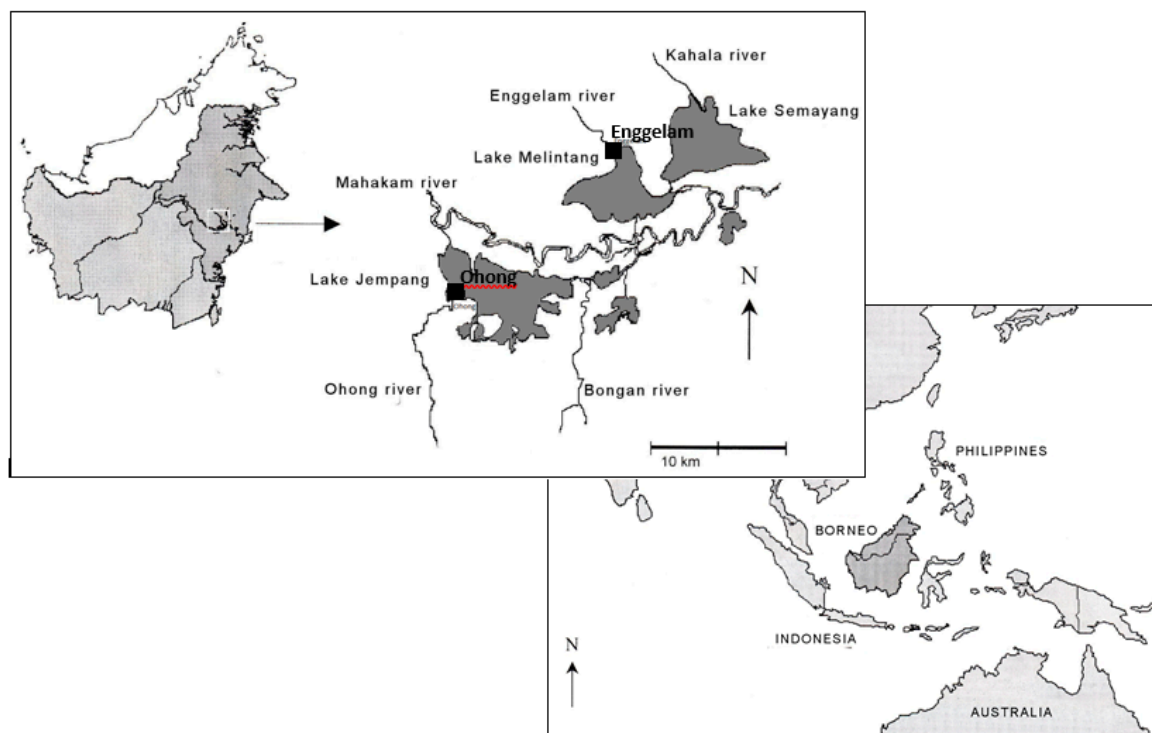


Figure 1. Map showing the Middle Mahakam lakes and research villages in the province of East Kalimantan, Borneo, Indonesia.

Most households in the village make a living from fishing, from breeding fish in *keramba*, and from occasional rice farming during the dry season. Most of the many kinds of fishing gear described above can be seen, ranging from simple traditional longlines to expensive nets that can be used to catch large quantities of fish. However, not everyone in the village can afford the latter. The most common fish species caught in this area are the local *haruan* (*Channa Striatus* or Snakehead Murrel) and the invasive *toman* (*Ophiocephalus micropeltes*, giant mudfish). While *haruan* are caught for both own

consumption and selling further afield, *toman* are all sold to other places in Kalimantan and even to Java. Around 80% of all households have *toman* in one or more fish cages, and 11% farm *haruan*. In general, fish catches in Enggelam are good and reliable, and the village is widely considered to still contain a lot of fish with large fish-catching areas.

The village of Ohong is located near the mouth of a river that flows into Lake Jempang. In 2005, 759 people were living in the village, divided over 251 households [54]. The village consists of two parts: a higher part, where the families of first-generation settlers live in wooden houses that are built on stilts on both sides of the river (about 70% of the village), and a lower part, where the newcomers live in floating houses located at the very mouth of the river (the remaining 30%) [55]. The upstream part is where the wealthy traders live, and where most of the village facilities can be found. The majority of the people living in the floating houses are Banjarese migrants from South Kalimantan, who make up around one-third of the overall village population. As in Enggelam, Kutai form the majority, while the Buginese population is less than 2%. As in most villages in the region, people's livelihoods consist of fishing, breeding fish in fish cages, and some rice cultivation. However, there are differences with Enggelam with regard to the volume and species of fish caught. There are far fewer fish in Lake Jempang, which results in generally small catches. *Haruan* is the main catch, and although many people also keep other species in their fish cages, they express a preference for keeping *haruan*. These are more resistant to poor water quality and are easier to keep than *toman* as they need to be fed less regularly. Around 58% of households in Ohong keep *haruan*, 40% farm *patin* (*Pangasius plyuranodon* or catfish) primarily for export, and only 14% keep *toman* in their fish cages. Whereas most villagers in Enggelam are involved in fish exports, in Ohong the fishing business seems to be in the hands of a few influential businessmen. Although other people catch or breed fish for export, they sell them to the businessmen who then resell them.

4. Methods and Analysis

To obtain a thorough understanding of the perceptions of changing water quality held by water-dependent communities as well as to grasp the whole gamut of dominant livelihood practices, we used a comparative mixed-methods approach. A range of research methods were sequentially applied between 2005 and 2015 to gather data on the various dimensions of the society of interest and to strengthen the validity and reliability of the study. These included quantitative data collection techniques such as the use of questionnaire surveys, as well as qualitative techniques such as participant observation, participatory appraisal (this included livelihoods and daily-activity diagrams (5), seasonal calendars (2), resource mappings (2), transect walks (4) and boat journeys (4), various mappings such as environmental changes (3), and oral histories (4)), and in-depth interviews. It is the combination of these techniques that enables us to explore and test our initial ideas and conceptual framework.

To investigate trends in water quality over the period 1992–2006, water quality measurements were carried out in the three Middle Mahakam Lakes during early July 2006 (between the wet and the dry seasons) and compared to water quality measurements taken in 1992. Subsequently, a baseline survey was conducted in 18 villages around the three major lakes in the Middle Mahakam Lake region (including some villages that are located further inland). The water quality measurements and the baseline survey led to selecting the villages of Enggelam and Ohong for further investigation. We purposively selected the two research sites based on three main criteria. First, the lake water near both villages seemed to be particularly affected. The lake water around Ohong showed extremely low values of dissolved oxygen, which could prove lethal for fish, while we found low alkalinity levels in Enggelam, triggered by an increased acidic input, possibly as a consequence of deforestation, mining activities, or the drainage of peatlands [5]. Second, there were notable differences in people's perspectives on the changes in the environment. To various extents, some people in Ohong had observed changes in the water quality although there were many who had not noticed any change in water quality. Conversely, in Enggelam, most of the people seemed to be rather positive about the

quality of the lake water. Third, to increase representativeness, the case study villages included most of the livelihood activities that are practiced in the region.

The development of the questionnaire followed an extensive period of qualitative inquiry. The combination of qualitative research methods and techniques allowed us to identify important issues and test the “sensitizing concepts,” such as patterns of livelihood activities and changes in the environment. Through this, we attempted to increase the validity of the central concepts and the robustness of the questionnaire through better connecting to local people’s life worlds as well as including the most important variables and items that encompass the livelihoods of the local fishing communities. Alongside and after conducting the questionnaire, we collected further qualitative data on specific issues of importance, such as water quality change, but also on specific livelihoods, wellbeing, and health, both in the research villages as well as in other villages in the region to verify our data and develop our conceptual frame further in an iterative process. This so-called triangulation of different methods and techniques enhances the quality and reliability of data [56].

The selection of households in the two villages for the survey was based on structured random sampling, with a proportionate distribution across the various neighborhoods and relative to the numbers of floating houses and houses on stilts. In total, we gathered information from 90 households in Enggelam and 121 in Ohong. The sampling procedure was structured in the sense that we tried to cover a representative number of households divided across the various neighborhoods but also random in that we knocked on doors and moved on to the next house if nobody was at home. If the number of respondents from a specific neighborhood was too low, we returned on a different day or at another time of day. In addition, we have conducted 24 open interviews that are directly related to this paper but have also conducted more than 100 open and semi-structured interviews both in the research villages and elsewhere in the region in the period of investigation that strengthened our insights. The respondents in the case-study villages were selected through a combination of structured random and snowball sampling. For the interviews, we selected an adult in the household, either the head of the household or his or her partner. We coded the interviews before constructing a thematic and domain analysis. Prior to each interview, we asked the respondents for their consent. To protect the privacy of the individuals described, we do not use any names in this paper.

Given that the village headmen had granted us official permission to conduct research in their villages and that we were already familiar to most of the population due to our presence in the village for some time while conducting the qualitative research, 99% of the households approached agreed to participate (in fact, only one person refused. Sometimes, people were busy or involved in urgent matters and asked us to return at another time which we did).

To increase the reliability of the answers provided to the questionnaires, five local Indonesian students were trained as interviewers to ask the questions in face-to-face interviews and record the answers given. The responses in each questionnaire were extensively checked on completion for thoroughness by the authors. The questionnaire was developed in the Indonesian language (sometimes using local vocabulary) to enhance unambiguity and prevent mistakes in translation by the research assistants. The first author is fluent in the Indonesian language but, to ensure validity, the questionnaire was checked for correct wording and interpretation by various Indonesian colleagues who also had a mastery of the English language. The data were entered into SPSS in the Indonesian language and translated after analysis.

The survey was constructed so as to include individual characteristics, such as age, gender, education, and ethnicity, information on the household level, such as number of fish cages, types of fishing gear and boats, and questions on the perception of changes in the water quality and quantity. Tables A1 and A2 (Appendix A) include descriptive statistics of the most important variables used in our analyses on the household and individual levels.

To compare households, we constructed a welfare index. To compute this index, we summed the total value of fishing equipment, fish cages, and boats, and divided this by one million rupiah. This was on the basis of our open and semi-structured interviews with the local population where

these variables were seen as the most important indicators, used by locals themselves, to categorize people into various wealth categories. This calculation of a welfare index revealed two outliers, one in each village. These families had substantially more assets than anyone else in the village and, as they were not representative of other villagers, we excluded them from the analysis.

In both a cluster analysis and the principal component analysis, we looked at the number and types of boats, petrol use in liters per day, number of *keramba*, types of fish in people's *keramba*, and the amount of fishing equipment. This was because, through participatory appraisal methods, such as mobility mapping, construction of livelihoods, daily life, and seasonal diagramming, as well as participant observation and open and semi-structured interviews with local people, we identified those variables as the most important in differentiating the various livelihood practices prevailing in the case study villages. In addition, these variables also provide insight into the way people interact with and are dependent upon the natural environment, most specifically the quality of the lake water.

The number and types of boats, as well as the size of engines and the amount of petrol they use on average per day, provide an indication of the amount of fish that people are able to catch as well as the distances they usually travel to catch fish. In combination with the fishing equipment, this provides a fairly comprehensive overview of a fisherman's fishing style. The equipment people use reveals whether they are more of an "old-fashioned" type of fisherman, using hand-made bamboo instruments, or an easy-going fisherman applying more modern equipment, such as electrical fishing devices, or somewhere in-between using combinations of various equipment. The fishing equipment used also points to the types and sizes of fish that are caught since these live in different parts of the lake, in shallow or deep water, and are more or less prone to water quality changes. In terms of boats, we looked separately at the numbers of *perahu* boats, *ces* boats, motorboats with 6 or 9 hp motors, those with 16 hp or larger engines, and longboats. *Perahu* boats are slightly larger than the more common *ces*. Fishing equipment was divided into *rengge/pukat*, *pancing/rawai/ancau*, *penggilar/bubufjeba*, *hampang*, *lukah*, *trol*, *strom*, *antaro*, *tempirai*, and *sanggah* categories.

In addition, the number of *keramba* and the fish species (*haruan*, *toman*, *jelawat*, *jele dumba*, *patin*, and *gabus*) kept in these floating breeding cages, and whether this goes on alongside other fishing practices tells much about people's way of living as well as their experiences with water quality changes. Some fish species are more costly (to purchase, feed, and keep healthy, with some requiring lots of antibiotics) and difficult to raise (both in terms of vulnerability to diseases and duration before they are large enough to sell) than others, and some species are more susceptible to sudden water quality changes than others.

Determining the dependent variable, perception of water quality change, was based on nine items on perceptions of changes related to the lakes concerning fish species, amount of fish, reproduction, number of fish species, lake depth, width of the lake, floods, human skin diseases, and fish diseases. These items were included because they had been identified by the respondents involved during participatory appraisals, such as environmental change mappings and rankings and open interviews. They were coded as: -2 = major deterioration or destroyed, -1 = some deterioration, 0 = no change, 1 = still fine, and 2 = better. One person in Ohong and two in Enggelam did not answer these questions and were consequently excluded from the analysis.

To uncover patterns of coherence between the various livelihood practices, the first step was a hierarchical cluster analysis using the Ward method [57], followed by applying the relocative method based on a "squared Euclidean distance method". This method considers both internal homogeneity (objects that show similarities but fall in different clusters) and external diversity (objects that show no similarities and fall into different clusters). The method used establishes a measurement of similarity based on the number of shared characteristics calculated for each pair of objects. This so-called Ward-cluster method starts by placing each household in a separate cluster. Subsequently all households that score the same for a variable are put together and the clusters that show the most similarities are combined. As the everyday circumstances are similar in Ohong and Enggelam, it was expected that the livelihood styles would also turn out to be similar. Therefore, the cluster analysis

combined the data from both villages to get the same livelihood styles in both villages and enable comparison. This also had the advantage of creating a greater sample size, potentially increasing the significance of the findings.

The second step comprised a regression analysis involving four models. The first model included only the individual-level variables. In the second model, the household variable “welfare index” was added, and the third model considered livelihood styles (which were based on the cluster analysis) but without the welfare index. Finally, the fourth model included all the variables. The regression analyses were carried out for each village separately since the aim was to reveal differences between villages.

5. Results

Before we explain, through livelihood styles, why there are differences in perceptions of water quality changes, we explore the general views people in Enggelam and Ohong concerning changes in their environment.

5.1. An Inside Look at the Environmental Changes in the Middle Mahakam Lakes

Table 1 presents the average scores on the nine statements developed concerning changes in the lakes. From the table, it can be concluded that, overall, the people evaluate the changes in the lakes negatively: that all aspects of the lake have deteriorated. Table 1 also presents the means for each village separately. On six of the nine statements, the average perception of people from Ohong is more negative than those from Enggelam.

Table 1. Average scores and standard deviations for nine statements on lake changes. The scores are in the range from −2 to +2, with negative scores reflecting negative perceptions.

Statements on Lake Changes	Overall		Enggelam		Ohong	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Quality of the water	−0.76	0.805	−0.45	0.829	−0.98	0.710
Number of fish	−0.73	0.853	−0.55	0.853	−0.86	0.833
Reproduction	−0.15	0.399	−0.09	0.388	−0.20	0.402
Number of fish species	−0.79	0.631	−0.96	0.656	−0.67	0.585
Depth of the lake	−0.51	0.597	−0.54	0.641	−0.49	0.565
Width of the lake	−0.35	0.553	−0.47	0.623	−0.26	0.476
Floods	−1.05	0.614	−1.04	0.689	−1.06	0.555
Human skin diseases	−0.19	0.440	−0.06	0.315	−0.29	0.492
Fish diseases	−0.37	0.625	−0.26	0.703	−0.45	0.548
N		209		89		120

The most striking changes mentioned by the people of both Ohong and Enggelam concern the increased number of floods and the decrease in their predictability, closely followed by a decline in the number of fish species, the volume of fish caught, and the water quality. To gain a more detailed understanding of the results in Table 1, Pearson’s correlations were calculated between the two locations for the nine statements. This showed that it was the perceptions of changes in the water quality, both within and between the two villages, that varied the most. Three-quarters of the inhabitants of Ohong were negative or very negative about changes in the water quality while the rest had not noticed any change at all. In Enggelam, the picture was far more varied: while about half of the population thought that the quality of the water had deteriorated, 38% had not noticed any change and a little over 10% even perceived positive changes in the water quality. Our earlier measurements had found that the lake water at both locations was very acidic, akin to swamp conditions, with very low oxygen levels; see [5]. When asked about the reasons for the changes, many villagers blamed the mining companies and plantation enterprises, although over one-third did not know why these changes had occurred or would refer to Allah as the source and cause of climatic changes. A few also mentioned previous forest fires. A quarter of the villagers mentioned logging activities in the river’s

watershed. All these were external causes, and very few villagers mentioned activities by the villagers themselves as being to blame. The people in Enggelam who were positive about the water quality were of the opinion that the water in the lake near the village was very good and drinkable, based on its clarity and there still being a considerable number of *toman* fish to be found.

In both villages, fishermen, women fish-processors, and traders were able to clearly indicate which species of fish had been caught and at which time of the year over recent decades. A gradual shift could be observed in the number of fish species caught since the late 1990s. The change has been from fish with a high market value to fish with less value, and from fish that live in pH-neutral waters to those more typical of swamp environments. Many villagers also mentioned that fish were smaller nowadays and that some species they had caught in the past had disappeared. Nearly two-thirds of the villagers (60%) mentioned this decrease in the quality and market value of fish catches.

The only exception to this pattern concerns the *toman*, a predatory fish originally found in the Barito river (South Kalimantan). It is a popular fish among Banjarese with a high market value in Banjarmasin. Originally, it was introduced in the Mahakam area to be reared in fish cages but some escaped and bred in the lakes and rivers of the middle Mahakam area—a persistent rumor is that a well-known trader from South Kalimantan, released *toman* on purpose into Lake Jempang. He supposedly said that he sought to increase the production and catches of this expensive fish to improve his trading opportunities in South Kalimantan. The predatory *toman* competes strongly with other fish. Fishermen can only recall catching *toman* since the late 1990s.

In terms of health issues, almost one in six villagers (16%) in Ohong mentioned an increase in waterborne diseases, such as diarrhea and vomiting (*muntaber*), and skin diseases, compared to just one person in Enggelam. Perceptions of water quality are closely related to its color. “Sometimes the water is milky, at other moments it is totally transparent. Prior to the mines, the water never had these colors,” was a typical remark. In more than half of the comments, the Ohong villagers blamed the coal pits upstream for the changes in water color and quality: “they release poisonous waste into the water; it makes us ill.” Someone else added: “you can see it when they release waste, they mix lime with the water to hide it and the color goes milky and then clear.” Explaining the color of this water, one fisherman noted, “if your knife drops into the water while you are cleaning fish, you can still see it at a depth of two meters. In the past, when the water was still brown and less transparent, you could not see more than 20 cm. At times when the water turns brighter, the fish (especially *baung*) run away. They detect it immediately if the quality of the water is getting worse. However, the fish in the cages are not able to escape and therefore more prone to changes in the quality of water.”

A few others mentioned the acidity of the water, including a former member of the village administration: “due to government regulations, they need to reduce the poisonous acids in the waste. They do that with lime, I have seen it myself.” Next to the changing color, villagers argued that the taste of the water had changed and sometimes “smells like rotten eggs” - this would seem to indicate that the amount of sulfur is increasing). When looking at the perceptions of the people living in the two villages, it can be concluded that villagers in Enggelam have a more positive perspective on their environment and water quality than those in Ohong (see Table 1).

From now on, we focus specifically on water quality changes as this was where there were the greatest variations, and we were puzzled by these differences given the similarity in our physical water quality measurements.

5.2. Identifying Livelihoods Styles in Enggelam and Ohong

We carried out a cluster analysis trying various numbers of clusters and concluded that five clusters appeared to be the optimum. Although more clusters could have been created, these five clusters could be clearly distinguished from each other in both villages. Increasing the number of clusters leads to greater variation in the size of clusters and the additional clusters could also be considered as sub-clusters of one of the five dominant clusters. Having fewer than five clusters lost some of the nuances. The five dominant livelihood styles that were present in Ohong and Enggelam,

following a relocation process, each had between 25 and 59 cases. The detailed characteristics of each cluster can be found in Table 2. First, we briefly describe what makes each style unique.

Table 2. Results of cluster analysis.

Variables	Clusters					Total N = 207	n	Sig
	1 N = 59	2 N = 25	3 N = 51	4 N = 36	5 N = 36			
have perahu	0.15	0.12	0.12	0.11	0.06	0.12	24	0.729
no ces	0.02	0.00	0.02	0.06	0.06	0.03	6	0.561
one ces	0.00	1.00	0.82	0.69	0.78	0.58	120	0.000 *
two or more ces	0.98	0.00	0.16	0.25	0.17	0.39	81	0.000 *
have ces 6 or 9 hp	0.93	0.00	0.98	0.97	0.78	0.81	168	0.000 *
have ces 16 + hp	0.76	1.00	0.08	0.14	0.19	0.42	86	0.000 *
have longboats	0.05	0.00	0.00	0.00	0.03	0.02	4	0.248
petrol 0–2.5 L/day	0.07	0.12	0.12	0.17	0.17	0.12	25	0.565
petrol 3–4.75 L/day	0.24	0.16	0.75	0.69	0.64	0.50	104	0.000 *
petrol 5 + L/day	0.69	0.72	0.14	0.14	0.19	0.38	78	0.000 *
no keramba	0.00	0.00	0.00	0.00	1.00	0.17	36	
one keramba	0.00	0.12	0.00	1.00	0.00	0.19	39	0.000 *
two or more keramba	1.00	0.88	1.00	0.00	0.00	0.64	132	0.000 *
have haruan	0.53	0.40	0.61	0.19	0.00	0.38	79	0.000 *
have toman	0.61	0.68	0.33	0.50	0.00	0.43	88	0.000 *
have jelawat	0.02	0.00	0.04	0.03	0.00	0.02	4	0.665
have jele/dumbo	0.02	0.00	0.00	0.00	0.00	0.00	1	0.647
have patin	0.25	0.04	0.53	0.25	0.00	0.25	52	0.000 *
have gabus	0.02	0.00	0.06	0.03	0.00	0.02	5	0.377
no rengge/pukat	0.05	0.12	0.18	0.06	0.22	0.12	25	0.057
few rengge/pukat	0.19	0.16	0.31	0.22	0.17	0.22	45	0.392
many rengge/pukat	0.76	0.72	0.51	0.72	0.61	0.66	137	0.053
have pancing/rawai	0.54	0.36	0.35	0.56	0.25	0.43	88	0.017 *
have ancau	0.42	0.72	0.22	0.19	0.08	0.31	64	0.000 *
have penggilar/bubu/jeba	0.39	0.16	0.37	0.25	0.31	0.32	66	0.220
have hampang	0.02	0.00	0.00	0.03	0.03	0.01	3	0.735
have lukah	0.12	0.08	0.10	0.06	0.03	0.08	17	0.570
have trol	0.12	0.04	0.02	0.00	0.03	0.05	10	0.050*
have strom	0.12	0.04	0.02	0.00	0.14	0.07	14	0.038 *
have antaro	0.05	0.00	0.02	0.00	0.08	0.03	7	0.227
have tempirai	0.14	0.04	0.08	0.28	0.19	0.14	30	0.041 *
have sanggah	0.15	0.08	0.08	0.06	0.06	0.09	19	0.426

* sig at <0.05.

- (1) Investors (59 cases): Individuals placed within this group have made considerable investments in a range of fishing equipment, boats, and fish cages. Of the groups, they have the most boats (each owning at least two), they all breed fish in cages, and use various kinds of fishing equipment. This allows them to spread risks. They have both modern and traditional fishing equipment. Most people who own *trols* fell within this group. In their cages, they breed both *toman* and *haruan*.
- (2) Boatmen (25): Everyone in this group had one boat with a 16 hp or larger motor. This enables them to cover large distances. Most people in this group have two or more fish cages, although some only have one. They mostly breed *toman* and, to a lesser extent, *haruan*. In terms of equipment, compared to the other groups, they have a lot of *ancau*, and also have many *rengge/pukat* and *pancing/rawai*.
- (3) Breeders (51): This group own many fish cages and focus on breeding, thus minimizing their exposure to changes in the lakes. They stand out from the other groups in that they breed considerable numbers of *patin*. They also breed the most *haruan* and keep some *toman*.
- (4) Traditional fishermen (36): This group uses mainly traditional equipment such as *pancing/rawai*, *tempirai*, and *rengge/pukat*, but do not own large quantities, meaning that their income from fishing is rather low. Some of them have a fish cage in which they generally breed *toman*, and some own a boat with a small motor.

- (5) Indolent fishermen (36): Members of this group do not own fish cages. The majority of this group uses *strom*, an electrical fishing device that enables a large catch in a single event. Most fishermen in this group have a boat with a 6 to 9 horsepower motor. They are locally referred to as indolent or lazy because they catch a considerable number of fish with little effort in a short time. The electric field created by the *strom* stuns the fish, that then float to the surface where they can be easily collected by the fishermen.

When we take a closer look at the various styles detected through the cluster analysis, we see that the largest group of households (29%) can be styled as investors, followed by breeders (25%). This is very much in line with the observations described above: that people need to invest more to maintain similar income levels and that there is an increasing trend to turn to fish cage breeding in combination with fishing or even instead of fishing.

5.3. Relating Perceived Water Quality Changes to Individual Characteristics, Wealth, and Styles

As anticipated, the individual variables do not adequately explain the differences in perceptions among the villagers (see Table 3). In the initial regression analysis, only gender had a significant effect. Men experience the changes more negatively, probably because they are more involved in fishing than women.

Then, in the second model, we added a welfare index. In Ohong, the welfare index had a significant effect, and the variance explained increased substantially, showing that the poorer you are, the more negatively you perceive the changes. This seems reasonable, as poorer people will be more affected by any changes. That a similar effect was not found in Enggelam is attributed to the generally more positive outlook in that village.

When including the clusters but omitting the welfare index from the regression model (Model 3), the explained variance increases substantially. In Enggelam, three of the clusters have a significant effect relative to the reference category (the indolent fishermen). Breeders perceive the changes in water quality the most negatively, followed by the boatmen, the traditional fishermen, the investors, and least of all the indolent fishermen. This can be explained by the fact that the indolent fishermen tend to use a *strom*, an electrical fishing device that can catch a lot of fish at once. By using these, they can maintain the size of their catches, even if there are fewer fish in the lake due to a deteriorating water quality. Not owning fish cages, they are also less likely to notice any changes in the quality of their fish. The investors are also less likely to be strongly affected than many others because they spread their risks by using different fishing methods. The fact that *patin* is difficult to breed, and prone to water quality changes, could explain why breeders in Enggelam, where breeding *patin* is quite popular, perceived negative changes in the lake's water quality. In contrast, in Ohong, the breeders had a more positive view of water quality changes than the indolent fishermen. A plausible explanation here is that the fish stock in the nearby Lake Jempang is decreasing more rapidly than that in the more distant Lake Melintang as the overall water quality of the latter is much better. As a consequence, the indolent fishermen need to travel much farther to catch large quantities of fish.

Finally, in Model 4, we included all the variables. Although gender still had a marked effect in both villages, it was weaker than in the first model. On adding the welfare index in this model, the cluster effects stayed the same in Enggelam. However, in Ohong, the welfare index no longer had a significant effect (unlike in Model 2) for the cluster of breeders (Cluster 3), while the explained variance increased.

Table 3. Regression effects on perceptions of water quality.

	Model 1	Model 2	Model 3	Model 4
Enggelam				
Gender	−0.490 (0.205) **	−0.447 (0.212) **	−0.445 (0.203) **	−0.406 (0.209) *
Age	0.015 (0.009)	0.013 (0.0010)	0.013 (0.010)	0.011 (0.010)
Education	0.198 (0.313)	0.178 (0.314)	−0.090 (0.320)	−0.113 (0.322)
Ethnicity	−0.292 (0.208)	−0.307 (0.210)	−0.260 (0.203)	−0.288 (0.206)
Welfare index		0.006 (0.008)		0.007 (0.008)
Cluster 5: Indolent fishermen (ref.)				
Cluster 1: Investors			−0.294 (0.284)	−0.386 (0.304)
Cluster 2: Boatmen			−0.624 (0.299) **	−0.712 (0.316) **
Cluster 3: Breeders			−0.904 (0.317) ***	−0.913 (0.317) ***
Cluster 4: Traditional fishermen			−0.576 (0.307) *	−0.612 (0.310) *
Constant	−0.981 (0.714)	−0.999 (0.715)	0.087 (0.784)	0.090 (0.785)
R ²	0.100	0.107	0.203	0.211
Ohong				
Gender	−0.300 (0.139) **	−0.276 (0.139) **	−0.285 (0.142) **	−0.266 (0.142) *
Age	−0.006 (0.006)	−0.009 (0.006)	−0.007 (0.006)	−0.008 (0.006)
Education	−0.037 (0.214)	−0.067 (0.213)	0.066 (0.222)	0.018 (0.223)
Ethnicity	−0.044 (0.141)	−0.006 (0.141)	−0.006 (0.145)	0.010 (0.144)
Welfare index		0.012 (0.007) *		0.014 (0.010)
Cluster 5: Indolent fishermen (ref.)				
Cluster 1: Investors			0.337 (0.205)	0.077 (0.273)
Cluster 2: Boatmen			0.289 (0.283)	0.139 (0.301)
Cluster 3: Breeders			0.360 (0.195) *	0.312 (0.197)
Cluster 4: Traditional fishermen			0.158 (0.226)	0.139 (0.226)
Constant	−0.484 (0.525)	−0.539 (0.521)	−0.929 (0.576)	−0.928 (0.574)
R ²	0.063	0.089	0.097	0.114

Note. Gender is a dummy variable where female is 1 and male is 0. Although in the original survey there were further answer categories for education, it has been recoded as (1) no schooling, (2) primary school, and (3) higher than primary school. As Buginese immigrants formed a very small part of the population, for ethnicity purposes the Banjar and Bugis categories are combined. Both are immigrants and are distinguished from the Kutai that have lived in the region for a long time. That is, the effect of ethnicity distinguishes Banjar and Bugis (=1) from Kutai (=0).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parentheses.

6. Discussion

In our research in the Middle Mahakam Wetlands on both the “real” and the “perceived” changes in the natural environment, we found no direct correlation between people’s perceptions and the biophysical changes that had been taking place in recent decades, especially in terms of water quality changes; for more information, see [5]. In some places, where the water quality was measured as poor, some fishermen were of the opinion that the lake water still contained the best drinking water in the area. Conversely, some people referred to areas where they perceived the water as being of bad quality while our measurements proved the opposite. Given these contrary findings, we therefore explored, using the concept of livelihood styles, the perceptions of changing water quality in two fishing communities in the Middle Mahakam Wetlands.

As expected, individual variables explain little when it comes to the different perceptions of water quality change. Only gender had a consistently significant effect in all the models in both villages, indicating that men perceive the changes in water quality more negatively than women. A plausible explanation is that men are more involved in fishing than women and, through this, may more directly notice any changes in the lake water quality. Age, education, and ethnicity had no significant effects. A notable finding was that welfare had a significant effect in Ohong on perceptions, with wealthier people perceiving the water quality changes less negatively than did poorer people.

A possible explanation here is that the wealthier people are far less involved in day-to-day fishing practices but more in fish-cleaning and trading activities. However, more research is needed to verify this explanation. In Enggelam, no such effect of welfare level was found.

To further unravel the differences in local people's perspectives on water quality changes, we introduced the concept of livelihood styles. Through a cluster analysis, we identified five styles: investors, boatmen, breeders, traditional fishermen, and indolent fishermen. By adding livelihood styles to the regression analysis of perspectives, the variance explained increased substantially, especially in Enggelam. We found significant differences in the perceptions of people with different livelihood styles. For example, fish breeders in both villages have a far more negative perspective than indolent fishermen. This shows how people's perceptions of changes in the lake water quality are closely related to the dialectical way in which they interact with their environment, including through their fishing practices, as well as the social and cultural structures they are part of. This finding is in line with Kofinas and Chapin [7] (p. 55), who point to the importance of patterns of livelihood activities as key elements in setting the stage for sustainability.

As such, uncovering livelihood styles and related perceptions can assist in developing sustainable ways of living, or in identifying those groups of people that can play a significant role in working with nature and people toward sustainable livelihood strategies. However, what we could observe is a shift to less sustainable livelihood strategies in the villages. For instance, there is a large increase in fish cage usage. Most of the fish species in the Enggelam cages are predators and this creates a large demand for small fish as a feedstock. However, in Ohong, a shift has been made to species that need less feed and are, therefore, less vulnerable to temporary shortages (responding to the declining numbers of fish in Lake Jempang and the increasing seasonal unpredictability). Furthermore, the increased use of larger scale fish-catching techniques (i.e., trawlers, electric shocks) has led to less sustainable livelihood strategies. As a consequence, fishermen in the lakes area have had to shift to fishing for smaller species and, except for the invasive *toman*, large fish are now rarely caught. As an alternative, smaller and cheaper varieties of fish are nowadays commonly caught, processed, and sold.

There are very few opportunities for new livelihood styles, although an increase in lakeside agriculture can be seen [5,55]. In the dry season, rice is grown in the dried out lakes along the riverbed but the risks of failure—due to unprecedented floods—is high. In addition, wood (for houses, cages, roads, boats, and cooking fuel) has become expensive and harder to obtain. During flood periods, logging in the swamp areas has increased. In some areas, conflicts over resources, techniques, and fishing areas between established fishermen and migrants have been reported and documented by researchers [5,8]. Although incomes have remained relatively stable during the recent years of ecological degradation, investments and inputs have had to increase heavily to maintain these incomes. People work longer, fish farther out into the lake, use larger nets, use less sustainable techniques, and collectively risk exhausting the rivers and lakes. A collapse of the system can be anticipated if people continue to fish in such unsustainable ways and in such large volumes; for similar situations in other wetlands, see [52,58–61].

Although our study shows that adopting the concept of livelihood styles in addition to individual characteristics and welfare characteristics can help explain differences in local people's perspectives on water quality change, there are some noteworthy issues that warrant further investigation. First, we did not compare our models with a model that distinguished all the separate variables that we included in the cluster analysis. Although the use of overarching livelihood styles is preferable theoretically, because it allows different combinations of variables, and methodologically, because it reduces the number of variables allowing a more parsimonious model, it might be that some of the individual variables have significant effects on their own. Second, while we assumed that the identified styles would be similar in both villages, the different findings for the "breeders" in the two villages might suggest otherwise. Consequently, we would suggest further investigating, testing, and developing the concept of livelihood styles in relation to environmental changes in the Middle Mahakam wetlands and also beyond.

7. Conclusions

Bourdieu [16] (p. 18) argues that “social reality” is an object of perception and “social science must take as its object both this reality and the perception of this reality, the perspectives, the points of view which, by virtue of their position in objective social space, agents have on this reality.” On this basis, it is important to understand local people’s perspectives on environmental changes if one is to mobilize human action. This current study, in the Middle Mahakam Wetlands, shows the added value of using the concept of livelihood styles when seeking to explain differences in people’s perspectives on water quality change.

We can confidently conclude that livelihood styles, as patterns of practices, shape people’s perceptions of local ecological changes. As such, the livelihood style concept can contribute to a more nuanced way of explaining why, and what kind of, differences exist in perceptions of environmental change. The approach can provide a mid-level explanation, above the individual but below the community or societal level, and is relevant when seeking to identify groups or clusters of local people that will be most inclined to cooperate with sustainability programs. It could even be used to indicate the types of people that could function as “change agents”—the “motor” behind processes towards sustainable development—and can aid in identifying an approach “to build both with local people and the actually natural nature” toward a sustainable environment, both in Indonesia and beyond.

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Appendix A

Table A1. Descriptive Information: Enggelam.

	Minimum	Maximum	Mean	Std. Dev
Individual-Level Variables				
Gender	0	1		
Age	20	60	36.10	10.00
Education	1	3	1.99	0.29
Ethnicity	0	1		
Household Level Variables				
Welfare index	5.97	86.80	18.56	12.37
Nr. perahu boats	0	3	0.30	0.65
Nr. ces boats	0	3	1.51	0.71
Nr. motor 6 or 9 hp	0	2	0.90	0.61
Nr. motor 16 or more hp	0	2	0.58	0.58
Nr. Longboat	-	-	-	-
Petrol use in litres	2	20	4.91	3.05
Nr. keramba	0	5	1.75	1.09
Have haruan	0	1	0.11	0.32
Have toman	0	1	0.82	0.39
Have jelawat	0	1	0.01	0.11
Have jele dumbo	0	1	0.01	0.11

Table A1. Cont.

	Minimum	Maximum	Mean	Std. Dev
Have patin	0	1	0.05	0.21
Have gabus	-	-	-	-
Rengge/Pukat	0	100	21.39	23.04
Pancing/Rawai	0	2000	243.70	441.89
Ancau	0	10	1.47	2.27
Penggilar/bubu/jeba	0	100	16.36	29.53
Hampang	0	100	1.15	10.72
Lukah	-	-	-	-
Trol	0	10	0.15	1.08
Strom	0	8	0.20	0.90
Antaro	0	40	0.92	6.03
Tempirai	0	100	5.40	20.28
Sangghah	0	3	0.24	0.53
Valid N (listwise) = 87				

Note. Gender is a dummy variable where female is 1 and male is 0. Although in the original survey there were additional answer categories for education, it has been recoded as (1) no schooling, (2) primary school, and (3) higher than primary school. As Buginese immigrants formed a very small part of the population, in terms of ethnicity, the Banjar and Bugis categories were combined. Both are immigrants who should be distinguished from the Kutai that have lived in the region for a long time. That is, the effect of ethnicity distinguishes Banjar and Bugis (=1) from Kutai (=0).

Appendix B

Table A2. Descriptive information: Muara Ohong.

	Minimum	Maximum	Mean	Std. Deviation
Individual Level Variables				
Gender	0	1		
Age	14	65	34.20	11.61
Education	1	3	2.03	0.32
Ethnicity	0	1		
Household Level Variables				
Welfare index	0	55.40	15.24	10.13
Nr. perahu boats	0	2	0.07	0.31
Nr. ces boats	0	4	1.44	0.76
Nr. motor 6 or 9 hp	0	3	1.02	0.64
Nr. motor 16 or more hp	0	2	0.40	0.61
Nr. longboat	0	1	0.03	0.18
Petrol use in liters	0	50	4.78	5.00
Nr. keramba	0	7	2.02	1.51
Have haruan	0	1	0.58	0.50
Have toman	0	1	0.14	0.35
Have jelawat	0	1	0.03	0.16
Have jele dumbo	-	-	-	-
Have patin	0	1	0.40	0.49
Have gabus	0	1	0.04	0.20
Rengge/Pukat	0	100	13.92	16.37
Pancing/Rawai	0	2000	199.58	342.81
Ancau	0	7	0.91	1.83
Penggilar/bubu/jeba	0	500	29.58	63.85
Hampang	0	2	0.02	0.18

Table A2. Cont.

	Minimum	Maximum	Mean	Std. Deviation
Lukah	0	120	6.95	20.61
Trol	0	2	0.05	0.26
Strom	0	4	0.05	0.39
Antaro	0	80	1.77	10.99
Tempirai	0	100	7.24	20.29
Sanggah	-	-	-	-
Valid N (listwise) = 119				

Note. Gender is a dummy variable where female is 1 and male is 0. Although in the original survey there were further answer categories for education, it has been recoded as (1) no schooling, (2) primary school, and (3) higher than primary school. As Buginese immigrants formed a very small part of the population, for ethnicity purposes the Banjar and Bugis categories are combined. Both are immigrants and are distinguished from the Kutai that have lived in the region for a long time. That is, the effect of ethnicity distinguishes Banjar and Bugis (=1) from Kutai (=0).

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