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Crop raiding and local people's attitudes on Bawean island, Indonesia, with a focus on the Endangered Bawean warty pig (*Sus blouchi*)

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ABSTRACT

Crop raiding by wild animals can cause damage to local farmers' fields with substantial economic losses especially in rural areas. On the other hand, local people's response to crop damage, such as hunting, can seriously imperil the populations of threatened species. Perceptions and attitudes shape these human-wildlife conflicts. In this study we investigated the extent and characteristics of crop raiding and protection measures employed on Bawean island, Indonesia, with a focus on the endemic and Endangered Bawean warty pig (*Sus blouchi*). We furthermore explore the attitudes of local people towards crop raiders, wildlife in general, nature and ecosystem services. We interviewed 52 respondents using a semi-structured design. Data were analysed descriptively and by using Cultural Consensus Analysis (CCA). We found that perceived crop loss was on average 28% and varied depending on the crop type and that different wildlife species targeted different crop types. People ranked pigs fourth after rats, macaques and insects as the most severe crop raiders. Protection measures employed for pigs always entailed the death of the animals. Attitudes towards nature and wildlife in general were positive, but negative towards crop-raiding wildlife. CCA revealed that attitudes in all domains (set of items that are of the same type) were in agreement amongst respondents, except for the domain wildlife. In conclusion, Bawean people are subject to crop raiding, but general perceptions of nature and wildlife are still positive. We expect that conservation initiatives will be accepted by local people and that our results can be used for the design of conservation projects and environmental education programmes.

Keywords: Agriculture, conservation, crop protection, Cultural Consensus Analysis, environmental education, human-wildlife conflict

INTRODUCTION

Sundaland is listed amongst the top biodiversity hotspots based on the number of endemic species and habitat loss (Myers *et al*., 2000; Brooks *et al*., 2002). Indonesia faces some of the highest deforestation rates in the world with more than 90% of the island of Java's natural vegetation having been lost due to conversion to agriculture, urban development and large-scale plantations (Sodhi *et al*., 2004; Santilli *et al*., 2005). Java accounts for just 7% of Indonesia's land area, but is home to 67% of its human population (Lavigne & Gunnell, 2006). This results in an enormous pressure on biodiversity (Smiet, 1990; Sodhi *et al*., 2004; Miettinen *et al*., 2011). Approximately 7% of Java is declared as protected area, however these areas continue to suffer from on-going resource exploitation, forest clearing and general management problems (Curran *et al*., 2004).

A similar situation applies for Bawean island, an approximately 200 km^2– large island in the Java Sea, off the coast of East Java, Indonesia, where large areas of the forest that once covered most of the island have been converted into agricultural land (Mantra, 1998). Secondary mature forest remains in the island's interior and is protected by a Strict Nature Reserve (*Cager Alam*, IUCN Category 1a) around the peaks of the central mountain area and a Wildlife Sanctuary (*Suaka Margasatwa, IUCN Category IV*), covering the rest of the central forests as well as four other fragmented smaller forests (Nij-man, 2006; IUCN and UNEP-WCMC, 2015). However, park boundaries on Bawean are poorly demarcated and illegal logging, burning and conversion into agricultural land is widespread (Mantra, 1998; Nijman, 2006; Nursyamsi, personal communication). The island is faunistically most famous for the endemic Bawean deer (*Axis kuhlii*), probably the rarest deer in the world (IUCN, 2015). Another endemic species is the Bawean warty pigs (*Sus blouchi*), which is described as being different from the mainland Javan warty pig (*S. verrucosus*, Groves & Grubb, 2011) and has a population of about 180 to 400 animals (Rademaker *et al*., 2016). It is listed as Endangered on the IUCN Red List under *S. verrucosus*. The decline in forest area and encroachment of human-modified landscapes on Bawean island pushes wildlife into cultivated areas, where they find easily accessible, abundant, nutritious and palatable crops (Santiapillai & Ramono, 1993).

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Agricultural fields near protected areas are often crop-raided by wild animals (Naughton-Treves, 2001; Hill, 2004; Fungo, 2011). Human-wildlife conflicts intensify as agriculture expands into wildlife habitat following human population growth or shifts of farming systems. These changes result in the co-existence of humans and wildlife and/or the wildlife populations being packed into protected areas by hunting pressure outside the protected zones (Naughton-Treves & Treves, 2005). This human-wildlife conflict challenges local people who sometimes loose substantial amounts of crops to wildlife, and also conservationists who try to win the support of local communities to ensure efforts to protect threatened species are long-lasting (Fungo, 2011). Crop protection techniques such as hunting and shooting may result in the death of animals (Santiapillai & Ramono, 1993; Marchal & Hill, 2009). Warty pigs are not legally protected in Indonesia, thus hunting outside protected areas on agricultural fields is legal. Additionally, local people may not only develop a negative attitude towards the crop-raiding species, but also wildlife and nature in general. Due to the low population size of Bawean warty pigs, the negative effect of hunting on the population may be of serious concern to the survival of the species.

The aim of the present study is to investigate the characteristics and extent of crop-raiding by wild animals on Bawean island, especially warty pigs, including the identification of which species raid crops, the proportion of crops being damaged and what crops are targeted by different species. We report on the measures that are used to protect crops from wildlife. We finally investigate the attitudes of local people on Bawean regarding crop-raiders, wildlife in general and benefits offered by nature and whether these attitudes are shared amongst local people. This information is important to understand the problem of crop raiding and may help to find solutions that satisfy farmers on the one hand and mitigate the negative impacts on wildlife on the other hand. Details about attitudes and how they are shared between people may be used in the design of environmental education projects. We generate recommendations that can be used to design community-based conservation efforts and conservation awareness programmes.

MATERIALS AND METHODS

Study site

We conducted our study on the 192 km^2-large island of Bawean, situated in the Java Sea approximately 120 km north of East Java and 250 km south of Kalimantan, Indonesia. Bawean is a volcanic remnant with several peaks of above 600 m asl. The weather on the island is seasonal with heavy rains from mid-October to March and extremely dry weather from April to November (Mantra, 1998; Payeur, 2015). In 2010, the population of approximately 70,000 people lived in 30 villages, mostly located in the coastal plains (Hugo, 1995; Irwanto, 2015) and mainly depend on fishing and farming (Nij-man, 2004). A large proportion of the male population temporarily lives in other parts of Indonesia, Malaysia and Singapore to work. This has led to the island being called Princess Island (*Pulau putri*) or Island of the Women (*Pulau wanita*) (Hugo, 1995; Irwanto, 1915). Nearly all inhabitants of Bawean are Muslim (Farid et al., 2013a). After its split from the other islands of Sundaland approximately 10,000 years ago Bawean was covered with dense forest (Mantra, 1998) that has been reduced by human activities. The remaining five forested areas, mainly located in the centre of the island, were designated as protected areas in 1995 (total 46.6 km^2) (Semiadi & Meijaard, 2013). Despite being protected, small scale illegal logging and burning continues to occur due to a lack of clear protected area boundaries and a lack of resources to ensure enforcement (Nijman, 2006; Nursyamsi, pers. comm.).

Cultural Consensus Analysis

We used Cultural Consensus Analysis (CCA) to characterise attitudes of local people and how these perceptions are shared among respondents (Weller, 2007; Borgatti & Halgin, 2011; Stone-Jovicich *et al*., 2011). A CCA investigates cultural domains; sets of items that are all of the same type is called a cultural domain. Cultural domains are learnt and shared by members of the society and may differ between different cultural groups (Weller, 2007; Borgatti & Halgin, 2011; Stone-Jovicich *et al.*, 2011). For instance, while members of one culture would include maggots into the domain "edible objects", in another culture it would be unthinkable to eat maggots. However, in order to be a cultural domain, not all members of a culture have to agree on an item's inclusion in the domain. Domains furthermore have internal structures such as pairs of items can be compared (e.g. in the domain "fruits" the sweetness of two items can be compared) or ranked (e.g. ranking the sweetness of fruits). Items in a cultural domain can be single entities but also positive or negative statements that characterises the domain. These statements can be of a cognitive type (e.g. "grow on trees" for the domain fruit) or an attitude (e.g. "are tasty" for the domain fruits). The extent of sharing particular items comprising a cultural domain allows investigation of the contents and distribution of concepts among individuals (Weller, 2007; Borgatti & Halgin, 2011; Stone-Jovicich et al., 2011). Consensus analysis thus enables us to "infer whether there is a culturally central or a more diversified understanding of the domain within the local knowledge system" (Caulkins & Hyatt, 1999). In consensus analysis respondents have to answer a systematic set of questions (representing the items) that will be used to assess the amount of agreement among the group towards the cultural domain. Statistically it involves a factor analysis of an intersubject agreement matrix that is Bayesian-adjusted and corrected for guessing (Weller, 2007; Stone-Jovicich *et al*., 2011). Three sets of questions may be answered (Stone-Jovicich et al., 2011): (1) To what extent does a group share a single cultural domain? (2) If there is consensus, what is the central belief and how does each individual agree with it? (3) What are the „culturally correct answers" to each item in the domain? Three assumptions apply: Respondents share a common culture, answers given by respondents are independent from all other respondents, and items are on a single topic and the same level of difficulty.

Data collection

We interviewed 52 respondents, who comprised the two stakeholder groups "authorities" (n = 31) and "farmers" (n = 21). Members of the group "authorities" were for instance community authorities such as village heads, but some also worked in the protected area management as forest rangers or forest police. Most people of the group authorities owned agricultural land as well. If a respondent belonged to both stakeholder groups, we placed them into authorities.

We used semi-structured interviews with open-ended questions and free-listing (Bernard, 2006). All interviews were conducted in Indonesian language, with the help of one of the authors (SZ). All respondents were informed about the purpose of the study and participated voluntarily.

The first set of questions was designed to receive descriptive information about the personal and socioeconomic background of respondents and their perception of crop raiding. We collected data about respondent age, how much agricultural land the respondent owns (as an index of wealth), how far on average their agricultural lands are located from the forest edge, and the main crop type planted. Furthermore, we asked the respondents what proportion of their crops are lost to wildlife, which species were responsible for it, and what protection measures they employ.

In the CCA, based on a second set of questions, we aimed to explore four different domains: "crop-raiding species", "ecosystem services", the respondent's general attitude about wildlife (hereafter "wildlife") and the respondent's general attitude about nature (hereafter "nature"). As no other similar study had been done on Bawean, we conducted a pilot survey in June 2014 to collect more information about the domains by using free listing and open interviews. For the main research in November 2014 to January 2015 we created two ranking tasks with 15 items each for crop-raiding species and ecosystem services. We asked respondents to rank the species according to how severely they affect the farmers' crops, and rank ecosystem services according to their importance. Although aggregating ranked questions is not compulsory (Weller, Holt, pers. comm.), we decided to group raw rankings in broader categories to partially address for the lack of independence among the data (Borgatti & Halgin, 2011). For the domains wildlife and nature, we created two sets of 19 and 20 structured dichotomous questions respectively (true/false).

Data analysis

The first set of questions was analysed descriptively using percentages, means and standard deviations. After inspecting the second set of questions, we deleted six questions of the domain nature as all respondents gave the same answer (100% true), leaving us with 14 items in this domain. Nevertheless, we report the complete answer key in Appendix 1. We analysed the four cultural domains by using CCA performed with the programme UCINET version 6.578 (Borgatti *et al*., 2002). We followed the diagnostic criteria outlined in Stone-Jovicich *et al.* (2011), e.g. we report a consensus when the ratio between the first and second Eigenvalue is at least 3 to 1, weak agreement when the ratio is between 2.0 and 2.9 to 1, and no agreement if the ratio is below 2. If no or only weak agreement was found in a cultural domain, we performed the same analysis on the two stakeholder groups separately. We furthermore report the average group competence score that usually ranges between 0 and 1 and which increases with higher consensus. We investigated whether the age of respondents, the total area of their agricultural land and the average distance to the forest of their agricultural land correlates with their individual competence scores, e.g. how close their performance was in relation to the cultural domain. We used non-parametric Spearman's correlations, as data were not normally distributed. It should be mentioned that the individual competence score does not necessarily reflect the knowledge to a question with an ultimate answer, but rather how close the attitude of individuals is to the culturally shared belief. That means if there is a large deviation from the culturally shared belief this may reflect an extremely positive or negative attitude towards the domains. Finally, if a consensus was found in the tested domain, we report the culturally appropriate answers to the true/false questions and the culturally correct ranking. Although the competence score and the "culturally correct answer key" are not meaningful for domains that do not show agreement amongst respondents, we decided to report them. They have to be treated with caution.

RESULTS

Socio-economic background

Respondents were mainly male (96 %), born on Bawean (94 %) and were between 24 and 65 years old (average 42). All respondents adhered to Islam. Thirty-nine respondents owned agricultural land, of which 21 (40%) were farmers, thus depend on agriculture. Respondents who could reliably estimate the size of their land owned on average 1.6 ± 1.7 ha agricultural land (minimum 36 m^2, maximum 9 ha, n = 35). Agricultural fields were on average 1.2 ± 1.2 km away from the forest edge (minimum 0 m, maximum 4.5 km). Twelve people belonging to the stakeholder group authorities did not own any agricultural land. There was no significant difference in the size of the agricultural land between authorities and farmers (Mann Whitney U = 129.5, p = 0.561, n = 35), but the land of farmers was significantly closer to the forest edge (Mann Whitney U = 79, p = 0.022, n = 35). The respondents cultivated a total of 46 different types of crops. Respondents who owned agricultural fields grew on average six types of crops. Rice, coconut and teak were the most frequently reported crop types, while teak, rice and mahogany covered the most area (Table 1).

Crop damage and crop raiding

Most crop types were reported to be subject to crop raiding by wild animals frequently, except for teak and mahogany (Table 1). Mean crop loss averaged between all crop types was 28.9% (sd 11.2). Although variance was high, perceived crop loss is substantial; around 40% loss

Table 1. Perceived crop raiding of the most commonly grown crops amongst 39 resondents who owned agricultural land, and species perceived as responsible for crop loss. For information about species responsible for crop loss all 49 respondents were asked. Numbers in brackets: standard deviations.

Crop type	People growing crop type (%)	Mean area of crop type (ha)	People experiencing crop raiding (%)	Total crop loss (%)	Number of respondents reporting species to be responsible for crop loss						
					Insects	Monkey	Rat	Pig	Bat	Bird	Other
Rice	85	**0.60** (0.53)	97	31 (22)	45	10	29	5	0	10	3
Coconut	72	**0.17** (0.31)	89	29 (31)	4	22	3	5	1	0	0
Teak	54	**0.64** (1.07)	33	16 (32)	6	2	2	1	0	0	0
Banana	51	**0.09** (0.12)	95	41 (37)	10	15	2	4	2	0	1
Mango	51	**0.06** (0.09)	100	36 (24)	5	14	2	0	11	0	2
Mahogany	36	**0.23** (0.32)	21	9 (26)	0	2	1	1	0	0	0
Cassava	26	**0.19** (0.38)	70	33 (34)	2	4	4	4	0	0	0
Chili	20	**0.03** (0.04)	63	26 (28)	6	0	1	0	0	0	0
Bean	15	**0.01** (0.02)	83	22 (16)	2	0	2	0	0	0	0
Jackfruit	15	**0.14** (0.17)	100	46 (39)	0	5	1	1	0	0	0

for fruit, and around one third for other crops. Different wildlife species were reported to affect different crop types. While insects and rats mainly damage rice, monkeys crop raid rice and different fruits (coconut, banana, and mango), bats target fruits and birds damage rice. Pigs were only mentioned by up to five respondents for each crop type, with most damage done to rice, cassava, and coconut and banana plants.

Protection measures

While people mostly used poison and pesticides to get rid of rats and insects, birds were mainly scared away and people used a wider range of methods to protect crops against monkeys and pigs (Table 2). Almost half of the respondents mentioned scaring away for protection against monkeys. "Shooting" refers to the use of air pump guns with 4.5 mm led bullet, not loaded with live ammunition, and was used to scare away all kinds of animals, but also to harm pigs and monkeys. The most commonly reported methods to protect against pigs were hunting using nets, sticks, traditional knives (*golok, parang*), traditional spears (*tombak*) and dogs, as well as trapping (snaring and pits), methods ultimately lethal to the pigs. Respondents reported that all pigs are killed after being trapped and no pigs are sold for consumption. Carcasses are left where the animal is killed and eaten by dogs, other pigs or monitor lizards, burrowed or burnt. One respondent mentioned that monitor lizards are sometimes killed with poison and another that bats are killed with poisoned bananas.

Cultural agreement regarding severity of crop-raiders, importance of ecosystem services and general attitude towards wildlife and nature

Both ranking tasks regarding the domains crop raiders and ecosystem services showed high agreement amongst the respondents, e.g. a ratio between first and second Eigenvalue of more than 3 (Table 3). The true/false answers regarding the attitude towards nature showed a similar high agreement. In contrast, the ratio between first and second Eigenvalue for the domain wildlife was below 3, indicating that there is only a weak agreement amongst respondents. For this domain, we performed consensus analysis for the two stakeholder groups separately, however, both analyses revealed a weak agreement again. Mean group competence scores were high for nature, crop raiders and ecosystems (Table 3). No negative competence scores were found, indicating that nobody of the respondents had an extremely different or unusual understanding of the domain.

Using Man Whitney U tests, no significant differences of individual competence scores between the two stakeholder groups were found (wildlife: U=273, p=0.328, n=52; nature: U=247, p=0.140, n=52). Correlating individual competence scores per domain with the total size of owned agriculture land and the distance to the forest respectively did not reveal any significance. Only the competence scores in the domain nature correlated significantly positively with distance to the forest (Spearman's rho = 0.401, p=0.019, n=34). Age did not correlate significantly with competence score in any of the domains tested.

The culturally correct ranking and answers for each domain are given in Appendix 1. The domain wildlife showed only weak agreement, so the answer key has to be treated with caution. The culturally correct ranking using UCINET (Figure 1 and 2) almost coincided with the ranking of mean ranks between respondents, but actual values differed a little bit due to corrections for guessing that is added by UCINET.

DISCUSSION

Crop raiding

In rural areas like Bawean island where most people depend largely on farming, crop-raiding by wild animals can cause a serious impact on their livelihoods (Hill,

Table 2. Protection measures employed for different species on Bawean island. Percentages indicate the proportion of the protection measure mentioned for the respective species. Different methods could be mentioned for the same species. n = 38 respondents

Protection type	Detail	Monkey (%)	Pig (%)	Rat (%)	Bat (%)	Bird (%)	Insect (%)
Passive protection	Wooden fence	-	8	-	-	-	-
	Net	10	11	-	-	18	-
Non-invasive active protection	Scaring away (throwing rocks, air pump gun, noise)	47	10	-	30	81	-
Invasive active protection	Shooting (air pump gun)	15	12	-	-	-	-
	Hunting (with net, stick, knife)	15	66	11	-	-	-
	Trapping (hole, net) and snaring	10	44	8	-	-	-
	Poison / pesticides	15	-	100	80	-	100
	Smoking out	-	-	3	-	-	-
(Other)	Invite hunter	5	22				
Nr. of respondents		19	11	35	4	11	34

Table 3. Agreement in four cultural domains crop-raiders, ecosystems, wildlife and nature. Two CCAs were performed for the domain wildlife on the two stakeholder groups separately, as only weak agreement could be found for the group as a whole.

Domain	Analysis	Largest eigenvalue	Second largest eigenvalue	Ratio of largest to second largest eigenvalue	Fit of cultural consensus model	Av. group competence score
Crop-raiders	Ranking	34.037	3.527	9.650	good fit	0.812
Ecosystems	Ranking	28.265	4.494	6.289	good fit	0.717
Wildlife	True/false	20.745	8.332	2.490	weak agreement	(0.614)
Wildlife - only authorities	True/false	12.367	4.433	2.790	weak agreement	(0.607)
Wildlife - only farmers	True/false	8.560	3.865	2.215	weak agreement	(0.623)
Nature	True/false	38.373	4.766	8.051	good fit	0.844

1997). On Bawean, mean crop loss as estimated by farmers was almost a third. Apart from actual loss of crops indirect costs may occur, e.g. high protection investments, disruption of schooling for children due to guarding of fields during school terms, increased risk of injury from wildlife, and diseases such as malaria if fields have to be guarded at night (Hill, 2000; Naughton-Treves, 2001; Mackenzie & Ahabyona, 2012). Perceived crop-loss may be higher than actual crop loss (Hill, 2004; Fungo, 2011). Although even independent measurements that try to determine crop loss levels have been shown to be difficult, studies that compare these independent assessments with perceived crop loss found that farmers overestimate losses by as much as 30-35% (Fungo, 2011). However, estimates are not intentionally wrong and may not be unreliable and inaccurate, but just need to be appropriately interpreted (Fungo, 2011). Lack of compensation and interest from the government and conservationists provides strong incentive for exaggerations (Sitati *et al*., 2005).

The three animal groups that are reported to cause the most damage to fields on Bawean island are insects, monkeys and rats. Other studies in Asia and Africa confirm that primates are often considered to cause more damage than pigs (Hill, 2000; Marchal & Hill, 2009; Campbell-Smith et al., 2010). Nevertheless, pigs are still reported as being one of the major crop-raiding species (Hill, 1997; Campbell-Smith *et al*., 2010). Warty pigs in our study rank forth, with five or fewer people mentioning them as crop-raiders. As found in other studies (Hill, 1997), it depends on the crop-raiding species which crop types are damaged. Warty pigs on Bawean island are reported to damage rice and cassava, as well as coconut and banana plants.

Crop loss is influenced by a number of factors, such as proximity to the forest border, crop species planted, the season, or animal density (Hill, 1997; Naughton-Treves & Treves, 2005; Fungo, 2011). On Bawean island, except for timber, all types of crops are reported to be substantially crop-raided by wild animals,

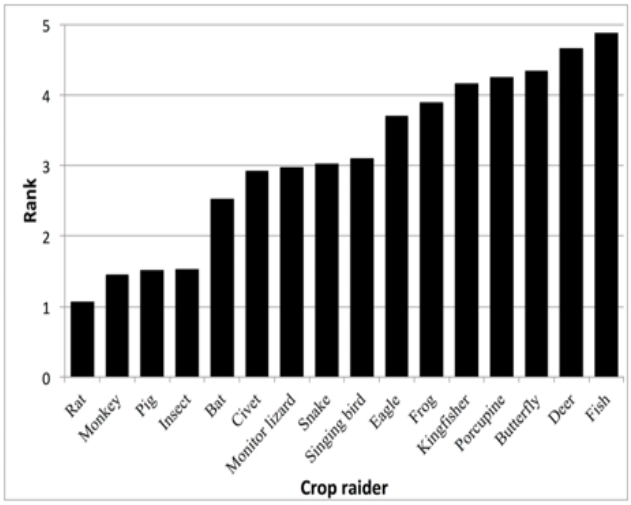

Figure 1. Severity of crop-raiding wildlife species, indicated by ranks, according to the perception of 52 respondents

and average crop loss per crop type ranges between 20% and 40%. In one of our tested domains – attitude towards nature - competence scores by individuals correlated significantly positively with the distance to the forest, meaning that the closer people live to the forest the more diverse their attitude is towards nature as compared to the culturally correct attitude.

Protection measures and hunting of pigs

A range of common protection measures against crop-raiding such as guarding and scaring away, fences, traps, poison and hunting (Hill, 1997; Osborn & Hill, 2005; Fungo, 2011) are used on Bawean island. Although guarding is usually reported to be the most effective measure to deter wildlife, this was only the case for monkeys and birds. Measures used to prevent damage by warty pigs on Bawean island pigs were hunting and shooting, which are always lethal for the animals. Hill (1997) found that guarding fields to protect against pig raids is regarded as ineffective because animals are nocturnal and their appearance is perceived as unpredictable. Additionally, people often fear pigs as they are perceived as dangerous and able to kill people (Hill, 1997).

As warty pigs are not legally protected in Indonesia, hunting and killing of animals is allowed outside the protected area. An unpublished survey from 2014 on Bawean by the authors revealed that all respondents know that hunting wildlife is prohibited inside the park boundaries. Nevertheless, illegal activities such as resource extraction (including catching birds) and fires do occur because borders are insufficiently demarcated and enforced (Rahim, pers. comm.). Ineffective or a complete lack of enforcement is typical for many of the "paper parks" in Indonesia that are legally protected but where deforestation and resource exploitation continues (Curran *et al*., 2004; Sulistyawati *et al*., 2008).

Although hunting activities in respect to pigs seem to only occur outside the protected area, it is of concern for the conservation of the species. A recent survey has revealed that only about 180 to 400 warty pigs are left on Bawean (Rademaker *et al*., 2016). As this species is endemic to the island this is the only population that exists. Warty pigs prefer community forest and edge habitat (Rademaker *et al.,* 2016; Rode-Margono *et al.,* 2016), making them highly susceptible to hunting. From a conservation perspective, due to low population numbers of Bawean warty pigs, it is necessary to develop non-invasive protection measures that are effective against pigs. As different protection measures are suitable to different wildlife species, Thapa (2010) suggests that the employment of single mitigation means is ineffective, and that solutions have to be site-specific. An exchange about different techniques, their effectiveness and associated costs between farmers, protected area management, government authorities and possibly agriculture research institutes could support the improvement of means (Thapa, 2010), while subsidies or compensations for farmers with high crop loss should be discussed.

Attitudes

The attitude of Bawean local people towards nature in general is good, with a high agreement between respondents. People seem to acknowledge the interdependencies between agriculture and nature and appreciate what nature offers them. Unpublished data collected by the authors about the perception of living on Bawean indicate that people are content and accepting, despite informal reports indicating that local salary is rather small or infrequently paid. The ranking of ecosystem services shows that benefits offered by nature are mainly attributed to services that directly affect agriculture. Tourism, research and wildlife in contrast rank last. Possibly these items do not bear any obvious benefit to local people. There is only little tourist activity on Bawean, and research is conducted rarely, possibly with little explanations, involvement or reporting to local communities.

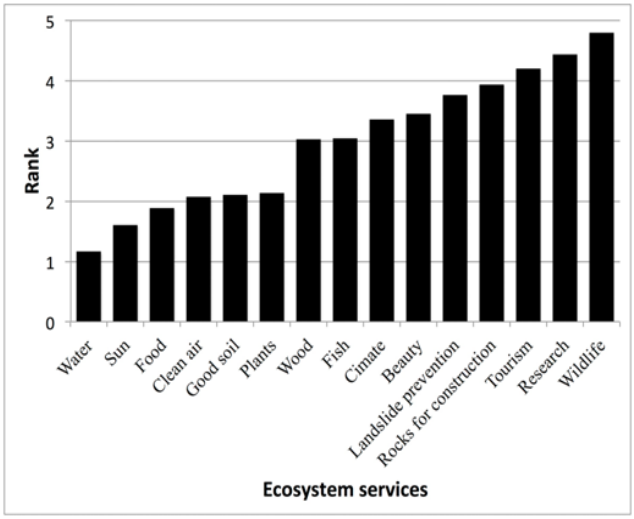

Figure 2. Importance of ecosystem services, indicated by ranks, according to the perception of 52 respondents

Looking at the answer key in the domain wildlife (Appendix 1), there is little agreement amongst the respondents, however, we could not identify groups with uniform attitude. This confirms that homogeneity among people and their perceptions and resulting responses cannot be assumed (Hill, 2004). Generally, people seem to not mind wild animals as long as they stay in the forest. The majority of respondents say that most wildlife is disturbing and that they prefer fewer wild animals (both items 61.5%). On the other hand they know that wildlife on Bawean is unique and they want that their children learn about wild animals in school (both items 90.4%). The fact that almost all people agree that research and tourism have the potential to attract people to Bawean (94.2%; 86.5%), indicates that there may be a chance to improve the attitude towards wildlife by strengthening nature and wildlife tourism as well as research that actively involves local communities. Farid *et al.* (2013a) suggests that the cultural and social characteristics of Bawean island (e.g. local art, local wisdom) would be able to support tourist activities. Visitor numbers are increasing, with visitors especially interested in marine tourism objects such as coral reefs, white sand beaches, natural scenery, hobby fishing and culinary appeal (Farid *et al*., 2013b). Although generally transportation, road condition, accommodation and other faculties still need to be improved (Farid et al., 2013b), the unique wildlife on Bawean may be an additional tourist activity. A future study may explore respective options, such as opening the already existing breeding facilities for Bawean deer to interested tourists.

Pigs are perceived as a major pest species (Hill, 1997). Attitude towards certain species may not only be influenced by the amount of actual crop loss they cause. Socioeconomic factors and ecological factors have a high influence on how crop raiding wildlife species are perceived (Hill, 2004; Naughton-Treves & Treves, 2005). As reviewed by Naughton-Treves and Treves (2005) damage is seen less negatively if people own more land, have alternative income, invest less labour into the crops, or value wildlife in other ways (e.g. as a tourism attraction). The perception of risk is higher if people feel that they have little control over the situation, for instance if hunting is banned (Hill, 2004). The value of pigs may be low on Bawean as the predominant attitude to pigs on the island and on Java is heavily influenced by traditional Islamic teaching and pigs are regarded as Haram (ritually impure). Ecological factors include the type of damage wildlife causes, how conspicuous animals are, if they crop-raid in groups, and the circadian timing of raid (Litsinger *et al.*, 1982; Adesina et al., 1994; Naughton-Treves & Treves, 2005). The fact that pigs are large animals, live in groups, are nocturnal, are perceived as dangerous and cause well-visible und attributable damage, increases negative attitudes towards them.

CONCLUSION AND RECOMMENDATIONS

While the relationship of Bawean local people towards nature in general is positive, their attitudes towards wildlife that enters and raids their agriculture fields are very negative. Although monkeys and rats are listed as being more severe crop-raiders than pigs, the negative attitude towards pigs may be additionally influenced by socioeconomic, ecological and religious reasons. Protection measures employed to defend against pigs such as hunting and shooting are always lethal to the animals. Bawean warty pigs are not legally protected thus hunting them outside the protected area is allowed. Bawean warty pigs are endemic to the island and are threatened due to a low population size. Intense hunting may thus threaten the survival of the species.

The contrasting interests between farmers and wildlife conservation requires a multi-disciplinary approach, with good understanding of issues and an active involvement of all stakeholders in the development of long-lasting and sustainable solutions (Sillero-Zubiri & Switzer, 2001; Hill, 2004; Treves et al., 2006). Common education and awareness activities can be used to bridge the gap of understanding between different stakeholders. They can be used as a platform to create thorough understanding of crop raiding, but also to explain the uniqueness of Bawean warty pigs and to create pride or at least acceptance of this unique taxa. As Islam has a strong cultural influence on Bawean island, religious aspects should be included in the discussions, such as the respect for creation of all life in Islam (Kula, 2001; Mangunjaya, 2011; Mangunjaya & McKay, 2012). We found that attitudes amongst our respondents who comprised of farmers and local authorities were relatively uniform in the domain nature, which can be used as common ground. In contrast, attitudes were not found to be homogeneous in the domain wildlife. While we could not find the source of disagreement, this diversity of opinions may offer a hook for constructive discussion. After socialisation between different stakeholders, ideas for non-invasive protection measures for warty pigs can be developed together. Workshops should invite farmers, local and provincial authorities, ecologists who are familiar with the behaviour of animals, members of government authorities who are able to assess what financial or technical help they can give and people from the agricultural section who have an overview of possible protection measures. Finally, social scientists should be involved to understand which interventions could raise tolerance for human-wildlife conflicts and under which conditions people would be willing to change agricultural and crop protection techniques in order to reduce conflicts.

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