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Review

Property rights regimes, resource utilisation and biodiversity conservation in Eastern and Southern Africa

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Natural resources degradation threatens persistence of biological resources in many parts of Eastern and Southern African regions. In these regions, property rights regimes intractably influence resource utilisation and biodiversity conservation. Hitherto, the underlying causes of varied performances of property rights regimes are rarely collated. Consequently, resource policies are often flawed, resulting in pervasive systems failure and biodiversity losses. In this study, this particular information gap is interrogated by systematically reviewing various property rights regimes, their influence on resource utilisation and biodiversity conservation from wealthy of available literature. The results unravelled that the performance of various property rights regimes are influenced by levels of social capital, encompassing stakeholders' participation, trust, commitment and social networking at the base regardless of whether the property rights areby full hegemony or sanctioned by higher authorities.This findingcloselyapproximatestheconceptofenvironmentalsubsidiarityinnaturalresourcemanagement.Furth er, it is concluded that bottom-up self-institutional regulation and top-down state controlplay complimentary if not invasive role to each other. These approaches stimulate sustainable resource utilisation and biodiversity conservation, where legal actors are given full resource property rights to access, own, utilise and exclude intruders to avoid the 'tragedy of the commons'.

Keywords: Collaborative governance, environmental subsidiarity, sustainable development, natural resource management.

INTRODUCTION

Resource property rights are a suite of entitlements or bundle of rights to the bearers, especially over scarce resources (Demsetz, 1998; Klein and Robinson, 2011). Entitlements could relate to the income or utility that can be derived from resources which are sanctioned, or at least condoned, by society and protected by a higher authority (De Alessi, 1983; Bromley, 1992). The bearers may include the state, private actors and local communities. Appropriate rights are therefore imperative especially as human populations are ever growing in the resource dominated areas (Wittemyer et al., 2008), with increasing demands and claims over resources (Giller et al., 2008). Property rights are also theoretical constructs in economics for determining how are source is used and

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owned by individuals, associations or government Leeetal., 1996; Ostrom, 2008). As an economic good, Guerin (2003) has described the attributes of property rights as entitlements to use the goods, earn income from the goods, transfer the goods to others and enforce. Therein are a boundary rules that determine who has the rights to access, control, use and ownership (Denison and Klingler-Vidra, 2012). Thus, these rules define the distribution of the property rights. Over-utilisation and loss of biological resources arise from incompletely defined and enforced property rights (Libecap, 2009) and are dismal (Barbier, 1991; Sinclairetal., 2006; Lindseyetal., 2014). According to Millennium Ecosystem Assessment (2005), anthropogenic activities are among the major causes of biodiversity losses, especially in human-dominated ecosystems such as African savannas.

The property rights can be held under either of four different regimes: open access, public, common and private property regimes (Swanson and Barbier, 1992).Sources of the property rights of access, withdrawal, management, exclusion and transfer are varied. The property rights may be conveyed as *de jure* or *de facto* rights. *De jure* right are given lawful recognition by formal and legal instrumentalities. According to Schlager and Ostrom (1992), *de facto* rights are less secure than *de jure* rights. *De facto* rights originate from cooperative resource users who define, monitor and enforce certain rights but may not be recognised by the state. Thus, property rights institutions range from formal arrangements, including constitutional provisions, statutes and judicial rulings, to informal conventions and customs regarding the allocations and uses of property (Andelson, 1991). These property regimes regulate the actual functioning of the tenure in local settings and at multi-level scales (Berkes, 2006). However, most natural resources are not exclusively private or public, but are governed by a mixture of private and public institutions, which often contradict (Bromley, 1992).

Further, the actors in the administration of property rights would vary from authorised users, claimants, proprietors to owners (Schlager and Ostrom, 1992), and potentially forming institutions of sustainability (Hagedon, 2008;Bromquist,2009).The formation of regimes depends on the transaction costs defining, monitoring and enforcing property rights conferred by the parent institutions (Denison and Klingler-Vidra, 2012).Therefore, the distribution of the property rights would be skewed to actors' affordability. For instance, needs of poor people and small scale users are more likely to be met within common property regimes rather than private property regimes (Rohde et al., 2006; Lawry et al., 2014). Protection of given property rights are provided by the force of etiquette, social custom and formal legally enacted laws supported by the state, developed under rules of first possession (Lueck, 1998).

Property rights can either enforce or negate 'tragedy of the commons' postulated by Hardin (1968). Ostrom (2008) defines the commons as lands which rural communities possess and use collectively in accordance with community-derived norms. Further, commons maybe defined by the fact of their communal ownership, that they are acknowledged as being the shared property of a definable group of persons, undivided shares whether or not recognised in statutory law but governed by communal norms (Wily, 2011). Tragedy of the commons theory suggests that it occurs when individuals, acting independently and rationally according to each one's self-interest, behave contrary to the whole group's long-term best interests by depleting some common resources (Hardin, 1968).Typically, tragedy of the commons arises when it is difficult and costly to exclude potential users from common-pool resources that yield finite flows of benefits as a result of which those resources will be exhausted by rational, utility-maximising individuals rather than conserved for the benefit of all (Rankin et el., 2007). Tragedy of the commons refers to a particular type of uncontrollable communal property management system where individuals try to gain as much as possible in the short term without taking longer term needs of the community into perspective (Fabricius et al., 2001). Consequently, tragedy of the commons has occurred for instance in fisheries areas with about 80% of stock being fished at beyond their maximum sustained yield (FAO, 2009), wildlife overharvested to levels well below their carrying capacities (Lindsey et al., 2014) and forests degraded at extremely high rates (Alajarvi, 1996; Abdallah and Monela, 2007;ILUA, 2010; Henry et al., 2011; Chidumayo, 2012). On the contrary, appropriate property rights increase the incentives of households and individuals to invest, and provide them with better access to resources, their productivity and use (Deininger, 2003).

Hitherto, the impacts of property rights regimes in natural resources have either been underplayed or misconstrued by policy and decision makers, despite the long debates on issues relating to the subject. This review, therefore, evaluates property rights regimes in the context of their impacts, drivers and suggested solutions to numerous challenges in their implementation. The typology and effectiveness of the particular property rights regimes are discussed from multiple perspectives, giving examples from across the Eastern and Southern regions.

TYPES OF PROPERTY RIGHTS, FUNCTIONAL CONDITIONALITIES AND THEIR EXAMPLES FROM EASTERN AND SOUTHERN AFRICAN REGION

Open access regime

Open access property is a metaphor of the tragedy of the commons (Blewett,1995).Typically, open access property regime entails that the property is not owned by resource users, and no one can exclude anyone else from using it

(Denison and Klingler-Vidra, 2012). Therefore, it lacks resource governance and individuals exploit there sources as hastily as possible, thereby rapidly degrading the resource (Repetto, 1988; Libby, 1994). When effective enforcement is infeasible, users ‘‘who would willingly reduce their own appropriation if others did are unwillingly to make a sacrifice for the benefit of a large number of free riders…’’ (Ostrom, 1999). This scenario creates crisis to the resource management system and gives rise to system’s collapse (Folke et al., 2010). If, however, the government or the subsidiary authorities start to control the use of resources on that property then it ceases to be an open access property and is converted to state property (Guerin, 2003).

There are several examples of open access regimes that have occurred in Eastern and Southern Africa. Examples of open access resources in Eastern and Southern Africa include fisheries, forests and other non-renewable energy sources such as coal (Leal, 1998). For instance, Lake Kariba of Zambia and Zimbabwe was overfished because it did not have imposed rules like the “fish ban” (Submanian, 1996). In South Africa, the communal small farm areas of Leliefontein of Namaqualand experienced persistently higher stocking rates of livestock which led to a depletion of palatable perennials and loss of vegetative cover due to open access regimes (Todd et al., 1999). In Zambia, bush meat poaching can be considered as ‘prima facie’ evidence of market failure in sustainable resource utilisation as individuals receive benefits yet share the damage to the commons (Lindsey et al., 2014).Another example is overgrazing by mass introduced livestock on the Kafue flats in Zambia, depleting wildlife forage (Haller and Chabwela, 2009).

Public property regimes

Public property regime allows for cooperative ownership, where access of the resources is controlled by the authorities like the government (Guerin, 2003). Examples are state owned and managed national parks in many of states or expansive state farms for internationally marketed tobacco, tea and sugar (Adams et al., 1999). In some cases, the public property rights are enjoyed by responsible states at the expense of impoverished rural communities who receive limited benefit streams (Knox, 1996).Management effectiveness of state owned and managed protected areas is strongly linked to community involvement and benefit streams (Coad et al., 2010; Leverington et al., 2010). In the recent decades, several synergetic novel initiatives that include contractual parks and trans frontier conservation areas have been experimented upon to marshal multi-level support to property regime functions under collective property, owned by a group of individuals, whose access and use are biodiversity conservation and appear to be promising (Quan,2000;Child,2009a;GrossmanandHolden, 2009).

Common property regimes

Common property regimes are controlled by the joint owners (Ostrom, 2008). Due to difficult in excluding or limiting users, common-pool resources are prone to degradation (Ostrom, 1999).Therefore, tragedy of the commons occurs when unconstrained consumption of common-pool resources takes place (Dodds, 2005). The common property regimes differ from open access regimes in so far as there would be well defined ownership, access, use, controls through legitimate resource management institutions. However, the use rights of individuals can be delimited and regulated so that over exploitation of the resource does not result. For instance, grazing schemes in Zimbabwe’s communal lands demonstrated that when access to grazing was unrestricted, exploitation of communal grazing land by privately held livestock inevitably resulted in ‘tragedy of the commons’ (Barnes, 1978).Unconstrained use of common-pool resources by local communities and commercial users is a major conservation concern and continues to be a major cause of decline of biodiversity despite the key role the traditional leadership plays in enforcing management rules and local resource regimes (Wilson et al., 2006; Marks, 2009).

In Eastern and Southern Africa, several examples of natural common-pool resources abound and include fishing grounds, forests, populations of animal and plant species, wetlands and grazing lands for livestock, wood supply, medicines and farm land (Adams, 2004).Some southern African societies developed relatively effective indigenous institutions for the management of entire landscapes and their component ecosystems, when this was in their economic interest but these have not been resilient to emerging changes (Magole et al., 2010). Colonial legacy, later inherited by post-colonial governments, buttressed governance systems that ignored indigenous knowledge and commons practice (Haller and Chabwela, 2009; Magole, 2009; Mhlanga, 2009). In some cases, indigenous management regimes were replaced by sectorial or fragmented systems that focused on technical, anti-political rationales (Büscher, 2010).

In the case of wildlife resources, since many native communities were evicted by colonial governments from their ancestral lands when protected areas were proclaimed, local communities generally developed antipathical view of wildlife (Mwima, 2001; Child, 2004; Mbaiwa, 2007). Traditionally, conservation has focused on the establishment of protected areas under central government control and eviction of people residing in these areas but it has negative impacts on local livelihoods and sometimes results into increased poaching pressure (BrockingtonandIgoe, 2006; Makagon et al., 2014). To address such antipathy, government agencies and non-government organizations (NGOs) joined forces in the 1980s and 1990s to develop community-based wildlife programmes aimed at providing benefits to affected communities (Murphree, 1993).

However, common property rights which were based on traditional leadership were evinced and proclaimed by the state as flawed systems which caused natural resource degradation, legitimising state intervention in management of the commons (Leach and Mearns, 1996). Thereafter, local communities retained legacies as hunters and gatherers (Child, 2004; Marks, 2009). Exacerbated by extreme poverty and low literacy levels of resource harvesting, in many cases biodiversity conservation efforts involving local communities have been deemed unsuccessful in favour of 'fortress conservation' that seeks to exclude local people from resources in order to ensure their conservation (Büscher and Dressler, 2007). The intervention was a zeal for reform entailing mainly privatisation and nationalisation of communal resources (Magole, 2003).

However, one of the deterministic strategies the Eastern and Southern regions spearheaded was the return of rights from the state to local communities through the community based natural resource management (CBNRM) programmes (e.g. ADMADE in Zambia; CAMPFIRE in Zimbabwe, LIFE in Namibia and TRANSFORM in South Africa) and various partnerships (Hulme and Murphree, 2001; Fabricius and Koch, 2004; Dressler et al., 2010). CBNRM was poised to address the biodiversity conservation challenges through trans-formative collective action and devolution of resource user rights (Child, 2004). Unlike in open-access property regimes, common property owners have greater ability to manage conflicts through shared benefits and enforcement (Klein and Robinson, 2011). However, widespread central control of common-pool resources by the state occurs due to perceived inertia among the local actors (Rankin et el., 2007). One of the key challenges in managing common-pool resources is society complexities due to heterogeneity in actors' values and norms about commonly owned property resource management and inadequate supportive legislation. In order to minimise the challenges in managing common resources, membership rules have been applied to exclude non-members from common resources (Lawry et al., 2014). Subsequently, CBNRM models have either been unsuccessful or successful. For instance, CBNRM in Namibia has encouraged the recovery of wildlife and generated significant incomes (NACSO, 2008) while in Mozambique and Zambia both wildlife and associated incomes have dwindled over time (Lindsey et al., in press). The differences in the outcomes of common property rights in Namibian verses Mozambican and Zambian scenarios were due to unclear and weak proprietary rights to the resource users coupled with weak relational social capital among the resource actors like communities and wildlife agencies.

In Malawi, CBNRM focuses on natural resources within protected areas and allows the consumptive use of resources by communities adjacent to national parks and wildlife reserves but wildlife remains the property of the state (Arntzen et al., 2003).Mesterton-Gibbons and Milner-Gulland (1998) posited that Zimbabwean local communities used cooperative game theory to determine the conditions under which community self-monitoring would ensure conservation occurs. These researchers in Zimbabwe concluded that ''no self-monitoring agreement can be sustainable without a payment to each individual that exceeds the opportunity cost of monitoring even if no one is poaching''.

In Botswana, like in other states in the region, assumption was made that once local communities fully participate in natural resource management and derive benefits, they can develop a sense of ownership and will use their natural resources sustainably (Mbaiwa, 2007). In all the above stated illustrations, the focus was bottom-up programmes implementation. Users were usually local residents that traditionally relied upon the common-pool resource for subsistence and self-regulated consumption by imposing their own enforcement of restrictions, or partnering with local authorities to do so (Gibson and Marks, 1995; Ostrom, 1999). Simultaneously, they depended on the top-down regulations by the state for their legitimacy (Child, 2004).

Caughley and Sinclair (1994) and Mphale et al. (1999) gave an account of a pilot range management project in Lesotho, where the Government of Lesotho and the United States Agency for International Development (USAID) established a successful grazing association at Sehlabathebe in the Drakensburg Mountains, and gave it management control over a badly degraded watershed. A popularly elected executive committee was responsible for administering a grazing management plan which provided for the seasonal rotation of livestock among winter grazing areas near villages and summer grazing areas in the surrounding mountains.

Livestock found grazing in violation of the plan were subject to impoundment by range riders. Local sanctions and rules helped to control 'free riders', who could otherwise degrade the rangeland further. Other similar examples are found in such countries as Botswana, South Africa and Zimbabwe in Southern Africa (Scoones and Cousins, 1991; Rohde et al., 2006). Despite these innovative collective actions, several other areas remained exposed to 'free riders' of the commons, effectively giving rise to open access resource regimes (Dore, 2001), including where local institutions existed (Lindsey et al., 2014).Therefore, strong investments in capacity development of local institutions and governance structures are required (Fabricius and Collins, 2007).

Private property regimes

Private property regime is both excludable and rival, while rights to access, use, exclusion and management, appropriate stream of economic rents from use of and

investments in the resource, and the rights to sell or otherwise transfer the resource to others are controlled by a private owner or a group of legal owners (Repetto, 1988; Guerin, 2003). To a considerable degree, Eastern and Southern Africa have legalised and privatised the use of wildlife, encouraging hunting, tourism and the sale of meat, hides and horns for wildlife that remains *res nullius* (without formal owner) or state-owned (Hill, 1994; Lindsey et al., 2009). If certain conditions are met, governments have delegated to the owners of private land the full rights to control the use of wildlife on their land (Jones and Murphree, 2004). With incentive to reap the benefits, investment in the resource base will optimise the benefits received, and will ensure the resource is not depleted over time (Andelson, 1991).

For example, due to incentives to invest by the private owners, management of wildlife was enhanced in Zimbabwe, raising the average return on investment from 1.8 to 10.5%as compared to non-private wildlife entities (Moyo,2000). In the Southern Africa, private rights conferred on land owners such as game ranchers resulted in drastically increased wildlife revenues, expanded wildlife populations and enhanced habitats (Child, 2009b). Establishment of *de facto* private rights to wildlife reversed declining Namibian wildlife populations, and resulted in an 80% increase in wildlife on freehold land and a major boost to the national economy (Jones, 1999). In South Africa, game ranching developed rapidly and contributed significantly, ecologically and to local and national economies (Van der Waal and Dekker, 2000; Child, 2009b). In Zambia, game ranching industry has alsogrownrapidlysince1980s, contributing to biodiversity conservation, job creation and economies (Lindsey et al., 2013). However, implications of the contemporary global pressure created by 'land rush' (Cotula and Polack, 2012) regarding resource property rights regimes needs to be further studied.

Further, in Savé Valley Conservancy in Zimbabwe private actors partnered with the local communities to enhance benefits to local economies through improved conservancy financing and management (Lindsey et al., 2009). Partnership was born out of realisation that wildlife could not be effectively conserved in protected areas or on private land without the support of neighbouring communities (Kreuter and Simmons, 1994).Again, another example comes from contractual parks as one innovative conservation mechanism which has been popular in South Africa since the 1980s (Reid and Turner, 2004; Grossman and Holden, 2009). This kind of contractual parks are established on land owned privately, either by individuals or community groups, which are then managed by the national conservation authorities and effectively become part of the national protected areas estate. Management of contractual parks is carried out in accordance with a joint management agreement devised by a board comprising representatives of both the landowners and the conservation authorities.

Therefore, building relational social capital in such arrangements is inevitable in fostering partnership.

RESOURCE PROPERTY RIGHTS VS. BIODIVERSITY CONSERVATION

Resource property rights, resource use and biodiversity conservation are intractably linked. Accelerated over-harvesting of forest products and degradation of forests occurred after national governments declared themselves to be the owners of forested land (Ascher, 1995). Similar problems of overexploitation have occurred with inshore fisheries when national agencies presumed that they had exclusive jurisdiction over all coastal waters (Finlayson and McCay, 1998). The states usurp the rights from users based on pessimism about the possibility of users voluntarily cooperating to prevent overuse, leading to widespread central control of common-pool resources (Hardin, 1968). Consequently, the tragedy of the commons arises when it is difficult and costly to exclude potential users from common-pool resources that yield finite flows of benefits. As a result, the resources will be exhausted by rational, utility-maximising individuals rather than conserved for the benefit of all (Guerin, 2003). Thus, the problem of over exploitation is a result of the resources being under public rather than private ownership (WentworthandRatté,2002).Where government manages public resource property, the neighbouring local communities should be involved in beneficial partnerships with the state to ensure resource protection(Child, 2009a).Such engagement with local communities may follow the principle of environmental subsidiarity, where local communities will have the right to make choice of rational decisions over resource use and management (Ribot et al., 2010).

RESOURCE PROPERTY RIGHTS VERSUS COLLABORATIVE GOVERNANCE

Collaborative governance of natural resources is a multi-actor based social processing a collective action (Imperial, 2005). Such collective action can greatly caution decimation of natural resources in transient resource property rights governance especially where state governance structures become inadequate to counteract resource depletion (Gibson and Marks, 1995). CBNRM was founded based on the common property theory which was applied to discourage open resource access though promotion of resource ownership, control and use by local communities (Rihoy and Steiner, 1995) and emphasised participatory approaches (Twyman, 2000). It was realised by practitioners and scholars that local communities can only conserve and use these natural resources in a sustainable manner when they

Table 1. Key conditions determining the likelihood for success of a particular property regime in Eastern and Southern Africa.

Type of property regime	Key conditions for success or failure	Selected references
Open access regime	Absence of controls leads to systems failure. Implementation of effective internal and external controls by way of local rules, norms and practice as well as sound policies and effective management result in sustainably managed resources.	Submanian, 1996; Todd et al., 1999; Guerin, 2003; Folke et al., 2010; Lindsey et al., 2014.
Public property regime	Though exclusionary policies may appear enticing for policy makers and resource managers, community involvement has shown to be promising. Local integration in resource management and beneficiation enhances sustainable resource management. Through local involvement, transactional costs for resource management are lowered, thereby increasing success rates for biodiversity conservation.	Child, 2009b; Grossman and Holden, 2009.
Common property regime	Like in other regimes such as public and private property regimes, relational social capital plays a critical role in improving positive outcomes of resource management. In addition, clear proprietary rights and associated benefits to the resource users are crucial.	Wilson et al., 2006; Marks, 2009; Magole et al., 2010; Lawry et al., 2014.
Private property regime	Increased incentives, including ownership and use rights of the resources within a given jurisdiction and sound relational social capital environment stimulate sustainable utilisation and biodiversity conservation.	Moyo, 2000; Grossman and Holden, 2009; Child, 2009b; Lindsey et al., 2013.

derive benefits from them (Swatuk, 2005). In order to address these biodiversity conservation challenges, various models of institutional arrangements have been piloted in Eastern and Southern region (Lund and Treue, 2008; Child, 2009a) and their effectiveness are mostly yet to be assessed.

RESOURCE PROPERTY RIGHTS VERSUSSUSTAINABILITY

Sustainability of the property rights depends on legitimisation of the rights by local and state authorities (Mbote, 2005). Property rights play an important role in the sustainable use of resources as they create wealth to local communities and land owners, and enhance protection of resources and convey rights (Lyons, 1998; Anderson et al., 2013). The stronger the institutions and the rights, the less danger there is likely to the persistence of the common-pool resources (Schlager and Ostrom, 1992). Property rights ought to empower actors evenly within the existing institutional arrangements responsible for resource management (Brockington et al., 2008). Strong institutional functionalities, including use of formal and informal rules to give incentives to the actors, are essential for sustainable natural resource manage-ment (Hagedorn, 2008; Bromquist, 2009).Securing of property rights in resource management serves to provide for incentives for sustainable natural resource management and rural development (Demsetz, 1998). Convincing participants to have beneficial behaviour to the rest of the group requires that individuals trust that the desired outcome is attainable and that free-riders will not benefit (Rankin et el., 2007). If gains can provide the economic incentive to landowners to manage natural resources on a sustained-yield basis, species will be saved (Hobley, 1996). However, there are several threats to sustainability that need to be dealt with. For instance, oppressive state control and rent seeking behaviour can put the resource base at risk (Benjaminsen et al., 2013). Further, essential research on attributes of property rights would contribute to sustainability of biological resources (Diekert, 2012; Nkhata et al., 2012). As the tragedy of the commons is increasingly part of the conventional wisdom in environmental studies, economics and ecology (McEvoy, 1988; Leach and Mearns 1996), results and lessons from the tragedy of commons could proof relevant in the formulation of strategies and policies for sustainable natural resource management.

KEY REASONS FOR FAILURE OF VIABLE RESOURCE PROPERTY RIGHTS

There are several reasons for failure of what would be otherwise viable resource property rights. Key conditions for success or failure of a particular property regime in Eastern and Southern Africa are given in Table 1. The following are reasons considered to influence impacts of property regimes on resource utilisation and biodiversity conservation, and these can be dynamic and site specific. According to Lawrence (2000), failure to provide necessary conditions for a property rights regime to propel resource conservation through ownership rights results in degradation of the resource base. For instance, individual land ownership having more secured formal

property rights to land have resulted in more investment and improved productivity per unit area (Feder and Feeny, 1991). In different instance, fishermen who have clearly defined private rights are able to increase efficiency in the use of space and technology (Schlager, 1994) and generate a positive incentive for conservation (Bodal, 2003). A property rights system which includes the right to alienation is often considered the most efficient as it can be defined as equivalent to private property (Ostrom, 2003).Failures to implement alienation rules and participatory collective action have often led to degradation of the natural resources (Haller and Merten, 2008; Chabwela and Haller, 2010).

Previously, failure by governments to provide adequate preliquisite developmental facilities to local communities coerced local communities to become dependent on revenue remittances by the states from resource utilisation. Although CBNRM initially focussed on conservation approach, the rural development became more prominent over any other objective (Arntzenet al., 2007).This mismatch in the implementation of set objectives occurred even when certain local communities received exclusive rights and responsibilities over natural resource management from the state (Arntzen et al., 2003). Thus, failure to directly link conservation and development to cement promotion of environmental conservation and rural economic development through local community participation in natural resource management and other derivatives such as tourism development facilitated increased resource degradation (Leach et al., 1999; Twyman, 2000; Mbaiwa, 2004).

The property rights are often simplified and frail to articulate representation of a complex social-ecological system. For example, common-pool resources theory tends to concentrate on simple systems and common resource generates a predictable, finite supply of one type of resource unit (for example wildlife or tons of fish) in each time period (Ostrom, 2008). Further, resource users are assumed to be short-term, profit-maximising actors who have complete information and are homogeneous in terms of their assets, skills, cultural views and discount rates on harvesting.

The other limiting factor to improved resource property regimes is that transaction costs for establishing, implementation and monitoring can be prohibitive. For instance, Tanzania continues with one of the highest rates of deforestation in Africa despite having forest laws supporting participatory forest management, and local communities entering into agreements with the Forest Department to manage local forestland and forest resources (Abdallah and Monela, 2007). According to Abdallah and Monela (2007), local communities can also designate village land as protected forestland and can develop plans for sustainable use and conservation. To date, however, the country's participatory forest management experience has not significantly reduced the rate of deforestation and land degradation: programmes are expensive and time-consuming to establish; local forest departments often lack sufficient human and financial resources; and the benefits to communities have not been sufficient to offset their loss of unrestricted use of the forest resources. Similar scenarios have been experienced in Zambia's forests following Joint Forest Management pilot projects (ILUA, 2010).

CONCLUSION AND RECOMMENDATIONS

Sustainable natural resource management demands deterministic and collective action to halt momentous loss of biodiversity from overutilization. In Eastern and Southern Africa, much of biodiversity conservation challenges can be attributed to flaws in the implementation of resource property rights and even the absence of the property rights altogether as in the case of prevalent open access regimes. Tragedy of the commons occurs and is expressed in different forms of waning natural resources at multiple temporal and geographical scales. Institutions of governance, which will enable definitive local rules, hegemony and self-governing of actors would play a key role in progressive implementation of property rights beyond existing enabling legal provisions.

The role of local communities and other actors in resource dominant areas is important to safeguarding integrity of biological diversity. Integrative approaches are required to stimulate active participation of local resource actors. In order to maximise benefits and appropriately internalise costs of establishing and implementing appropriate property regimes among the actors, capacity building through information generation and sharing in addition to skills building is essential. Such strategies curtail the challenges of dearth of information, lapses in the taking advantages of economies of scale, internalisation of transaction costs and misinterpretation of legal and policy provisions among the actors. Land tenure should always, thus, be made supportive and clear to the actors. Therefore, functional social networks such as partnerships between governments and other actors are likely to improve collaborative governance of natural resources delivery of the property rights via joint ventures and other initiatives. Vices such as rent seeking and undue political power relations among different actors can be prevented by functional social networks and collective action.

Conflict of interests

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Assessment of changes in provision of forest ecosystem goods and services and benefit sharing mechanisms in the Ugalla-Masito Ecosystem: A case of Ilagala and Karago villages in Kigoma Region, Tanzania

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This paper presents results of the assessment of changes in provision of forest ecosystem goods and services in the Ugalla-Masito Ecosystem, using a case study of Ilagala and Karago villages in Kigoma Region, where REDD is being piloted. Various data collection methods were employed. These included focused group discussions, key informants' interviews, in-depth interviews using structured questionnaires and document analysis. The results indicate that the demand for forestry products in the ward is quite high compared to the level which the surrounding forest can supply. This includes demand for fuelwood, timber and building poles. The ecological footprint accounting techniques revealed that people in Karago need five to six times their available village area per year for fuelwood production, while for Ilagala, the requirement is 8.5 to 9.7 times. This implies that these villages have a very high ecological deficit. Regarding possible compensation for the forgone ecosystem services, the present study reveals that each household in the villages may need to be paid Tshs 1,919,000 – Tshs 2,586,000 ($ 1279-$ 1,724) per year as compensation for foregone fuelwood. The study recommends that there is a high need for conservation schemes such as the REDD project to cooperate with village governments in the farm field tree planting campaign as well as encouraging the use of improved stoves so as to cut down costs of fuelwood access in the foreseeable future.

Key words: Forest ecosystem goods and services, ecological footprint, benefit sharing.

INTRODUCTION

Forest ecosystems provide a wide range of goods and services from which people benefit, and upon which all life depends. Also, forests act as carbon sinks, resulting in an uptake of greenhouse gas - carbon dioxide (CO_2) from atmosphere. In this way, a forest plays important role in climate change mitigation (UN-REDD Programme,

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2009) such that it has now captured international attention (Intergovernmental Panel on Climate Change (IPCC), 2007; Stern, 2006).

Forest loss, primarily tropical deforestation and forest degradation, accounts for approximately 18-20% of global greenhouse gas emissions (IPCC, 2007). By reducing emissions from deforestation and forest degradation (REDD) through forests conservation, practices stabilize the atmospheric concentration of greenhouse gas (GHG) emissions, which, in turn, help avoiding global warming and increase forest goods and services (Angelsen and Wertz-Kanounnikoff, 2009).

The governments of Norway and Tanzania signed a letter of intent in 2008 for establishment of a partnership intended to address climate change challenges through reduction of emission from deforestation and forest degradation (REDD) (United Republic of Tanzania (URT), 2009). The government of Tanzania started by piloting REDD in various locations of the country. These include Mbeya, Sumbawanga, Kigoma, Shinyanga, Kondoa, Kilosa, Lindi, Mtwara and Zanzibar. The programme involves about eight Non-Governmental Organizations, which collaborate with the central and local government. Academic institutions and private sector are currently implementing the projects.

Despite the implementation, it is argued in IRA (2009) that there are some challenges of implementing REDD in Tanzania. These include heavy dependency on the natural resources base for livelihood sustenance and economic development. Some communities utilize forests for cultural and traditional activities. If these forests are put under the REDD programme, the activities will no longer be allowed to take place in the forest areas due to non-existence of known modalities for compensation as well as lack of national model for benefit sharing. In addition, there is no clear documented information on ecological footprint(s), which is the amount of land required for providing goods and services that people do consume in the specific project areas. This determines the extent which the flow of forest ecosystem goods and services might be affected in the forest-dependent communities upon REDD project implementation.

Kigoma Region, Kigoma Rural District in particular, is among the areas in Tanzania where the REDD project is at pilot stage. Communities covered by the REDD project areas have been foregoing forest ecosystem goods and services in favor of REDD project implementation, much as demand for forestry products in the district is quite high compared with what the district or region can supply. People frequently rely on forests for acquiring firewood and charcoal (for selling or using as fuel), timber and building poles (URT, 2008). It is argued in URT 2009 that the implementation of REDD project in Kigoma Region mighty interfere with the cultural and economic values of large number of indigenous people, if the aforementioned challenges are not immediately taken into account.

This paper thus confines itself to assessing changes in provision of forest ecosystem goods and services and benefit sharing mechanisms to local communities in Ugalla-Masito Ecosystem, using the case study of Ilagala and Karago villages. These are located in Kigoma Rural District, where REDD is being piloted. The main objective of the study was to present information on what the villages had foregone or prevented them from using the forest reserves, and, to make an interpretation of the expected plans for using money acquired from the possible compensation that the households may need to be given, as well as making interpretation of ecological footprint; which is the equivalent amount of land required to supply or maintain flow of the foregone forest ecosystem goods and services, based on the current household consumption level, particularly the foregone ones. These interpretations were done in accordance with pillars of ecological management which are preservation, protection and sustainable use of components or elements of Ilagala and Karago forest ecosystems.

MATERIALS AND METHODS

Case study description

Masito-Ugalla is one of the Kigoma Rural District's largest natural forest reserves. Due to high bio-diversity value of Masito-Ugalla forest, the international NGO (Jane Goodall Institute (JGI)) is currently implementing the REDD project with a vision to enable communities to benefit from REDD-based global approaches on climate change mitigation. The Project also focuses on seven villages, which include Karago, Sunuka, Ilagala, Kirando, Sigunga, Mwakizega and Songambele. The villages are located along the Lake Tanganyika shoreline lying within Kigoma Rural District, which protects about 700 sq. km of indigenous forests currently classified as general land. However, the REDD implementation approach in these villages links with participatory forest management (PFM). Assessment of changes in provision of forest ecosystem goods and services, as well as benefit-sharing mechanisms of local communities in the Ugalla- Masito Ecosystem, Ilagala and Karago villages, were taken as case study areas.

Karago village is bordered to the north by the Ilagala village, to the south by Sunuka village, to the east by Masito-Ugalla forest reserve and southeast by Songambele, and to the west by Lake Tanganyika. It has 8703 people (about 1600 households) (2012, census) and a land area of 11,219 ha has reserved five forests with a size of 5646 ha (Figure 1). However, the village has agricultural land of 5138 ha and 432 ha for settlement.

On the other hand, Ilagala village is bordered to the north by Mwakizega village, to the south by Karago and Songambele villages and the east by Masito-Ugalla forest reserve, and to the west by Lake Tanganyika. The village is has 21, 246 people (about 3500 households) (2012, census) with a land area of 23,840 ha. It has reserved three forests whose size is 3402.2ha (Figure 2). However, the village has agricultural land amounting 14880ha, 4905ha for settlement and a 653ha reserved forest for mining activities.

Agriculture is the major source of income for the majority of the people in Karago and Ilagala villages. However, the areas which are under agricultural utilization are very small. If the area under crop cultivation is distributed equally to the total population based

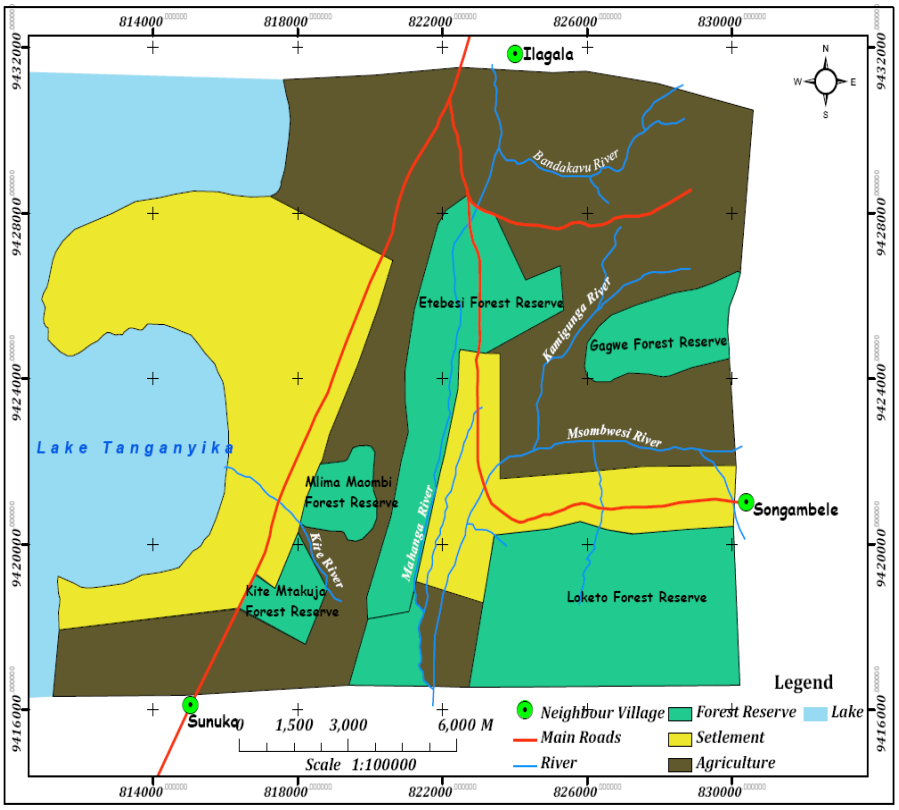

Figure 1. Map showing the land use of Karago Village.

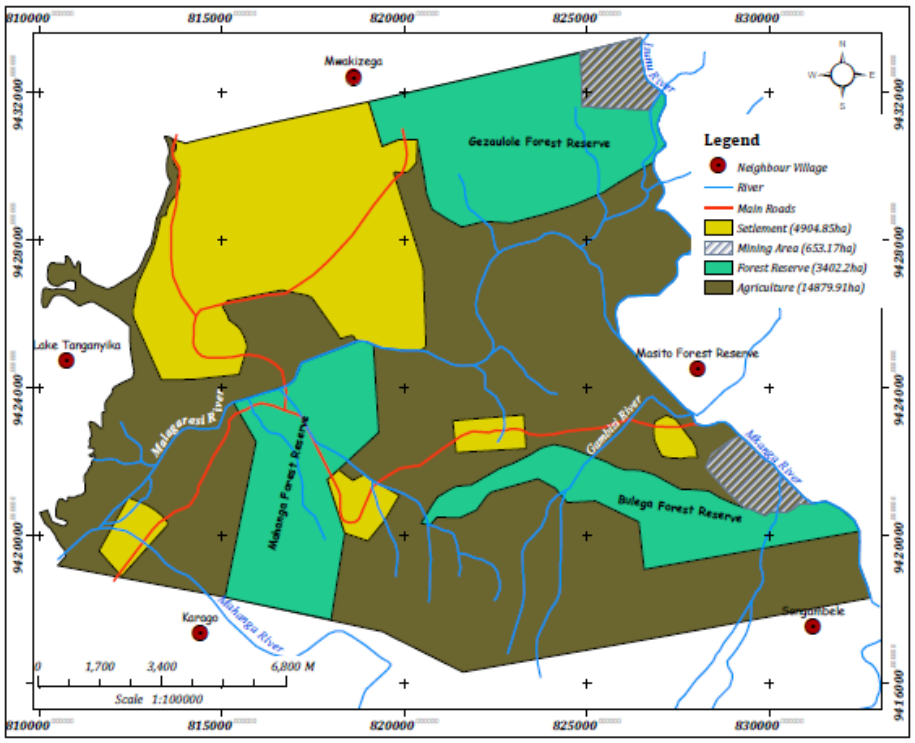

Figure 2. Map showing the land use of Ilagala Village.

Table 1. Characteristics of the interviewed households.

Village	Households interviewed	Sex		Age			Education level			Residence history	
		%Male	%Female	18-35	36-60	>60	Illiterate	Primary	Secondary	Born in the Village	Born in other village
Karago	30	80	20	30	70	0	3.3	86.7	10	86.7	13.3
Ilagala	40	65	35	25	72.5	2.5	2.5	97.5	0	72.5	27.5

on 2002 census, every single person in Karago village will be cultivating an area of about 0.6ha while in Ilagala the cultivation area will be 0.7 ha. Agricultural production in Karago and Ilagala villages depends mostly on natural rains for crop growing. The major crops include maize, beans, cassava, bananas, groundnuts and palm oil. Apart from cultivation, other socio economic activities include beekeeping, cattle keeping, carpentry and trading activities.

Data collection methods and analysis

A combined methodology that involved stakeholder meetings (qualitative approach) and household surveys (quantitative approach) was adopted. Consequently, multiple methods and techniques for data collection and analysis were used. Data collection methods included key informants interviews, focus group discussions and in-depth interviews using a standard questionnaire that was structured to obtain information on changes in provision of forest ecosystem goods and services as well as benefit-sharing mechanisms. Through the key informants interviews, various well knowledgeable representatives of actors at Kigoma Rural District level and the respective villages were interviewed. The interviewees also included representatives of the Non-Governmental Organization (NGO), the Jane Goodall Institute (JGI), which is implementing the REDD pilot projects in the respective villages. Other interviewed key informants included ward and village officials, religious leaders and primary school teachers. These were regarded as well knowledgeable people at local level in relation to natural resources issues. They were quite useful in advising on specific communities to be interviewed during the in-depth interviews that were carried out in their respective areas. Under the focus group discussions, meetings with village representatives of selected communities were held to discuss issues related to changes in provision of forest ecosystem goods and services as well as benefit sharing mechanisms in their respective villages. More information was collected through in-depth interviews using a structured questionnaire which contained both open and close ended questions. Under the in-depth interviews, a total of 70 household representatives were interviewed. Table 1 gives the characteristics of the interviewed households. However, during the field study, the following criteria were used in selecting the respondents, especially households:

a) Market access – people living near the roads and far from the roads or people living near or far from the forests.
b) Socio-economic activities of people involved in fishing activities.
c) Deforestation rates - areas with high and low deforestation rates.
d) Access to benefits - people receiving and those not receiving the benefits.

Most of the collected qualitative data was analyzed using content analysis. Content analysis was carried out for data that was collected through focus group discussions. Data collected from the questionnaire was analyzed by SPSS whereby descriptive statistics were determined. These include mean, standard deviation and percentages. Analysis of variance was carried out to determine the significance of variations in ecological footprint (fuelwood consumption) within and between the villages.

Determination of ecological footprint

To find out the ecological footprint for the fuelwood, the footprint accounting formula was used. The following were steps used in determining the ecological footprint for the foregone fuelwood.

1. Collection of data on fuel wood consumption in households during survey.
2. Assembling of ecological footprint table. This was done with the help of the Ecological Footprint conversion factors whereby relevant conversion factors were used.
3. Calculations of ecological footprint (EF) was done using the formula below:

$$EF = \frac{AC}{YF} \; X \; EFEF$$

Sources: Ewing et al., 2009; Ewing et al., 2008).
Whereby:

EFEF = Ecological footprint equivalent factor (gha-year /ha) (translates amount of fuelwood consumed into average universal unit of biologically productive area, a global hectare).
AC = Amount of fuel wood consumed in the area (tonnes or m^3/yearor m^3/year).
YF = Yield factor (tonnes /haor m^3/m^2) = 1 (tonnes /ha or m^3/m^2).

For firewood: AC = Percentage of households using firewood X total number of households in the village X household firewood consumption per week (m^3) X number of weeks per year.
For charcoal: AC = Percentage of households using charcoal x total number of households in the village X household firewood consumption per month (kg) X number of months per year.

Monetary valuation of the foregone forest ecosystem goods and services

The total monetary valuation of the foregone forest ecosystem goods and services, especially fuelwood, was done using the following method(s) of approximation as seen in Table 2.The method was adopted from Chopra (1993).

Table 2. Total monetary Valuation of foregone fuelwood per household.

Type of fuelwood	Cost code	Method of approximation
Firewood	Cost of firewood (PF)	PF= Household consumption per week X UNDP nominal price per m^3 X Number of weeks per year
	Cost of Labor (Time in collection) (CL)	CL=Time taken for firewood collection per day X Firewood Collection Frequency per week X UNDP nominal cost per effective hour X number of weeks per year
Charcoal	Cost of charcoal (MP)	Village Market price

Table 3. Spatial distribution of benefits derived from forest products to surrounding villages based on value classification.

Value	Goods and services	Local	Regional	Global
Direct use value	Honey	X	X	
	Charcoal	X		
	Firewood	X	X	
	Timber	X		
	Ropes and poles	X	X	
	Medicinal plants	X		
	Fruits, Nuts, Mushroom and Bush meat	X		
Indirect use value	Regulation of local rainfall	X		
	Water yield	X		
Non-use Value	Carbon storage and Sequestration			X
	Future direct and indirect uses of above goods and services	X	X	X
	Traditional/cultural knowledge & traditions	X	X	X

Source: Modified from Jaboury and Diane, 2005

RESULTS AND DISCUSSION

Forest use in Karago and Ilagala villages before and during REDD project

The results indicate that forestry products' demand in villages is quite high compared to the level which the surrounding forest can supply. This includes demand for fuelwood, timber and building poles. Ilagala and Karago villagers have been going short of supply of forest ecosystem goods and services since the REDD project was started. However, forests surrounding the villages have been beneficial not only at village level but also the regional level. This implies that by foregoing forest goods and services due to acceptance of REDD projects, there are both positive and negatives effects not only at village level, but also at regional level. Table 3 shows the spatial distribution of benefits brought by direct and indirect use of forest products acquired from the surrounding forests. Generally speaking, there is no statistical difference in households' dependency on forest reserves for gathering various forest ecosystem goods and services in Karago and Ilagala villages at 95% confidence level. This implies that their livelihoods have been equally connected with forest resources found in their village areas. However, upon acceptance of the REDD project, people have been completely prevented in accessing fuelwood from forest reserves. On the other hand, there are special forest reserves for acquiring some goods and services especially, fuelwood. This has affected people in terms of inadequate supply of construction materials and others who were dependent on these villages to get such products. Some of the people have shifted from the region and moved to other regions like Mwanza in order to seek areas where they can undertake some lumbering activity. The programme of reserving forests under REDD project has changed the pattern of timber and poles access, hence leading to the decrease in their supply.

Table 4. Household Consumption, Time and Frequency of collection of Fuelwood (Mean ± Standard Deviation).

Village	Household consumption of Firewood per week (m^3)	Household consumption of Charcoal per Month (bags)	Time for firewood collection per trip	Frequency of Firewood collection per week
Karago	1±0.5	0.75±0.2	6.2±1.4	2.3± 0.9
Ilagala	1.5±0.8	0.7±0.2	6.0±1.4	2.8±1.3

Table 5. Ratio between household land ownership and Household ecological footprint (mean ± standard deviation).

Village	Household size	Household land ownership (ha)	Household ecological footprint per year (gha)	Ratio of household ecological footprint per year and land ownership
Karago	5±3	7±2	46±30	16±15
Ilagala	8±5	6±4	75±40	20±12

Fuelwood Consumption in the villages and their accessibility during REDD project

An interview conducted at Ilagala and Karago village showed that 77-80 percent of households formally utilized the reserved forests for collecting firewood. However, 5-13% of households used the forest reserves for acquiring charcoal as a source of energy. These percentages of households' utilization of firewood and charcoal for cooking are less when compared with Tanzania- rural areas country fuelwood information for cooking of 2010 (91% use firewood and 8% use charcoal). The percentage of households who use the reserved forest products for fuelwood collection, particularly firewood, is the minimum percentage of people who use fuelwood at the moment in Ilagala and Karago villages.

However, the study reveals that most of charcoal produced was used for business, as it was sold in and outside the villages. Currently, the average household consumption of charcoal in the two villages is 0.75 of a sack per month for Karago village and 0.7 of a sack per month for Ilagala. One sack of charcoal carries 30 kg. Moreover, the current average household consumption of firewood for Karago is 1 m^3 per week and 1.5 m^3 per week for Ilagala and, the frequency of firewood collection is two to three per week. The time taken by household for firewood collection per trip is 5 to 7 h per day (Table 4).

Generally speaking, the supply of fuelwood per household (firewood and charcoal) has decreased since the programme of preserving forests was established. There is only one reserved forest for fuelwood collection. Thus, 45-77% of people are forced to use their agricultural land for the purpose, while some do not own land (3%-10%), hence making them face a hard time. Also, the average agricultural land in the two villages of those who own land is quite small. The individual agricultural land for Karago is 0.6 and 0.7 ha for Ilagala. Under normal circumstance, this land is insufficient to cater for agricultural activities and fuelwood demand. People having inadequate farming land might be contributing to the percentage of those who illegally collect firewood from forest reserve (2-7%) buying (13-43%).

Household ecological footprint

The interpretation of the current household fuelwood consumption behavior into equivalent amount of land required to provide or maintain the flow of fuelwood (ecological footprint of the foregone fuelwood) as well as data on household land ownership show that most of households possess insufficient land for fuelwood supply. Households in Ilagala village require 20 times their available land while Karago village requires 16 times their available land to cater for their fuelwood needs (Table 5). This implies that households in the villages have some very big land deficit per year for their daily fuelwood consumption. The average household land deficit in Ilagala is 69 and 39 ha per year for Karago. This shows that the land required for households fuelwood supply is less by 92% in Ilagala and 84.8% for Karago. Generally speaking, statistical analysis (analysis of variances) shows that there is significant difference in ecological footprint among and within these two villages (Ilagala and Karago) at 95% confidence level. This might be due to differences in type of cooking technologies used, number of people in the households or the easy availability of fuelwood among households.

Ecological footprint of Karago and Ilagala villages based on fuelwood consumption

The current amount of fuelwood consumed by Karago and Ilagala villages per year is mainly obtained from

Table 6. Ecological footprint of Karago and Ilagala Village based on foregone fuelwood.

Fuelwood	Fuelwood Consumption per household per year				Conversion factor (ha-year/gha)	Footprint per fuelwood(gha) per year			
	Karago		Ilagala			Karago		Ilagala	
	Min	Max	Min	Max		Min	Max	Min	Max
Firewood	64,064 m^3/year	75,712 m^3/year	218,400 m^3/year	248,430 m^3/year	0.93	59,579	70,412	203,112	231,040
Charcoal	56.2ton/ year	34.56 ton/year	44.1 ton/year	70.56 ton/year	0.43	14.86	24.20	18.96	30.34
Total footprint of fuelwood per village						59,594	70,436	203,131	231,070
Total available agricultural land per village / biocapacity						5,275.88		14,879.91	
Ecological deficit= Footprint-Biocapacity						54,318	65,160	188,251	216,190
`Total area for the villages						11,218.88		23,840.13	

Minimum value is based on percentage of households at field who used the reserved forest for fuelwood collection while maximum value is based on Tanzania- rural areas country fuelwood information for cooking of 2010 (91% use firewood and 8% use charcoal).

agricultural land. But, it is less compared to the amount they previously used to obtain from the forests, which are now reserved for the REDD project. Table 6 gives the ecological footprint of fuelwood, which shows the picture on the standard amount of space or land required to supply the total foregone fuelwood in the two villages.

The total ecological footprint for fuelwood of Karago village ranges from 59,594 to 70,436 global hectares per year (Table 6). This is an area of fuelwood production that should be solely dedicated to Karago village for its annual consumption of fuelwood. This amount land far exceeds the total area of the village. Due to the fact that the village sits on 11,218.88 ha of land, it means that it needs more than 5 to 6 times the available area for fuelwood production. This implies that Karago village almost has no land for fuelwood supply. The villagers are compelled to find other places to supplement the land deficit in order to maintain fuelwood supply. Based on the 2012 census, the village population was 8703 people, while the fuelwood footprint per capital was about 6.8 to 8.1 global hectares per year. Also, based on the total available land for agriculture from which fuelwood has to be accessed, it implies that some 54,318 to 65,160 ha are needed to cater for fuelwood needs for whole village. This implies that the land deficit for fuelwood supply at Karago village is less by 91 to 92.5%. This village land deficit (91 to 92.5%) is even greater than that of an average household land deficit (84.8%) by 6.2 to 7.7% within the villages.

Likewise, for the case of Ilagala village, the total area required to support fuelwood (ecological footprint) is about 203,131 to 231,070 global hectares per year. As the village sits on 23,840.13 hectares of land, it uses more than 8.5 to 9.7 times the available village area per year for fuelwood. Just as is the case with Karago village, this implies that the fuelwood footprint of Ilagala has also exceeded its biocapacity. People consume more fuelwood more than what is available within their boundaries. Based on the 2012 census, the village population stood was 21,246, thus the fuelwood footprint per capital stands at about 9.6 to 10.9 global hectares per year. Also, based on the available village agricultural land, from which fuelwood has to be harvested; it implies that a land size of about 188,251 to 216,190 hectares is needed to cater for fuelwood in Ilagala village. This implies that in Ilagala village, the land required to supply fuelwood is less by 93 to 94%. This village land deficit (93 to 94%) is even larger than that of average household land deficit (92%) by 1 to 2% within the villages.

In real sense, the extra land required by the two villages is not feasible, even if the reserved forests could be availed to the villages for acquiring fuelwood. Since the village land deficit in both villages is higher than individual land deficit, there is a very small possibility for the people being given sufficient land by village government(s). Thus if there were no efforts for forest conservations, it could have reached a point whereby the whole village land and their forests would be completely exhausted. That might be the reason why there was previously a high environmental degradation in terms of deforestation and forest dilapidation in the villages. However, when compared with the fair earth share which is 2 ha per each person, the Karago village ecological footprint for fuelwood would have to be reduced by 70.6 to 75.3 percent and 76.5 to 79.4 percent for Ilagala in order to be ecologically sustainable. This means that the average household firewood consumption for Karago should not exceed 0.3 m^3 per weekand 0.35 m^3 per week for Ilagala. Also, for the case of charcoal, the average household consumption for Karago should be 7 kg per month only and 3 kg per month for Ilagala.

Monetary value of the foregone fuelwood

Karago and Ilagala villages have accepted the implementation of REDD project and foregone the value

Table 7. A fair compensation for the foregone monetary value of fuelwood for households.

Type of Fuelwood	Cost Code	Nominal Cost (USD / Tsh)	Source	Monetary Value per year (USD / Tsh)	
				Minimum	Maximum
Firewood	Cost of firewood	18, 000 - 20, 000 /=per m^3	UNDP (2011)	1,040,000	1,560,000
	Cost of labor (time in collection)	0.5USD (750/=) per effective hour	UNDP (2011)	819,000	936,000
Subtotal				1,859,000	2,496,000
Charcoal	Cost of charcoal	8,000-10,000 per bag	Village charcoal businessmen	60,000	90,000
Grand total				1,919,000 ($1,279)	2,586,000 ($1,724)

utilization of the forests, especially the harvest of fuelwood. However, due to the high ecological footprint of the villages which does not correlate with the available land, people have almost no land in the village(s) for collecting fuelwood, hence have to go elsewhere and, if it is within the village, then it will be very far away from their residential areas. This has both time and distance implications. Thus, for the project to be fair, people may need to be paid 1,859,000 Tshs – 2,496,000 Tshs ($ 1239-$ 1,664) per household per year as compensation for firewood costs, and 60,000Tshs- 90,000Tshs ($ 40-$ 60) per household per year as compensation for charcoal costs. Therefore, in general, the total amount of money to be paid directly to each household in the villages is supposed to be 1,919,000 Tshs – 2,586,000Tshs ($ 1279-$ 1,724) per year for fuelwood consumption (Table 7). This amount is far bigger by 92-94 percent compared to the sum the project has promised to pay each household per year which is $ 100. Generally speaking, the promised amount of money for the foregone ecosystem goods and services is not sufficient to meet their needs. Household interviews and questionnaires revealed that people can neither use the promised money as the substitute for fuelwood nor for activities related to forest ecosystem management, but rather for doing unrelated activities like business and paying children's school fees. This constituted more than 44% of interviewed households in Ilagala and 30% of households in Karago villages. It implies that people have accepted the REDD project and foregone forest ecosystem goods and services so as to get cash to solve their problems.

Environmental and social implications of ecological footprint and monetary value of the foregone fuelwood in Ilagala and Karago Villages

It is clear that due to people's plans on the use of cash to be paid as a compensation of the foregone fuelwood, no matter how much the households will be paid, deforestation and forest degradation in the villages is likely to be very high, to the extent of nullifying the efforts of REDD project. The ecological footprints for both households in Ilagala and Karago villages and that of their respective villages are quite high, in comparison with global standards of ecological footprint. This is likely to increase even more since the population of these villages increases while the land is fixed and hence, more .ecological footprint. The amount of land available in Karago and Ilagala villages is not enough to meet their fuelwood demand (Table 6). The land required for firewood collection exceeds the available land; a situation of ecological overshoot is likely to occur and may lead to degradation of natural capital and a consequent decrease in economic and social welfare.

Since the majority (70-70.4%) depends on agricultural activities as the main economic activity in all village areas, this has implications on the conservation of the forest resources. This is due to the fact that if the land on which farmers utilize for farming in these areas losses fertility, they (farmers) will always tend to move towards virgin land so as to access fertile soils, which, in this case, is the forest reserves (Shemdoe et al., 2011). However, over exploitation of fuelwood and the unimodal type of rainfall with an overall trend that keeps on decreasing at the rate of 2.9 mm/year could aggravate forest degradation to the extent of exceeding the natural regenerative capacity of biomass.

High environmental footprint of the two villages implies that villages should depend on nearby villages to cater for the supply of fuelwood, thus the high likelihood of inviting social conflicts as people will compete for available land for fuelwood. Field study has revealed that there are already some land conflicts (20-42.5% of households), which, with time, will be transformed into worst case scenario. In addition, if there shall be no strict strategies on protection of forest reserves, people could even be tempted to collect fuelwood in the reserved forests due to long distance that people have to cover in search of firewood. Measures should therefore be taken to reduce household consumption of fuelwood by high percentage so as to avoid ecological overshoot and the associated environmental impacts. This, therefore, necessitates the

need for people to use fuelwood at a slower rate than they are regenerated. It goes without saying that if there will be no change in lifestyle while the populations of Karago and Ilagala villages keep on increasing, then the villages will experience even more deforestation and forest degradation in the future to the extent of nullifying the achievements of the REDD project.

Conclusion and recommendation

The study has indicated the most alarming environmental and socio-economic situations in a foreseeable future. The conservation initiatives should thus balance people's needs with sustainable development and consider investing more in their alternative livelihood projects as well as encouraging them to use high energy and efficient cooking technology. In regard to possible payments modalities, these should be done through their village government account in order to facilitate development activities that will benefit the whole village communities as well as protect and preserve the forests, not just some individuals. This study has generated useful information that needs to be taken into consideration especially when developing variable benefit sharing mechanisms in various REDD-based areas. The information could also be useful to agricultural developers, renewable energy investors, natural resources managers, hydrologists and environmental planners. The study recommends a high need for conservation projects such as the REDD project to cooperate with village government in tree planting campaign in the farm fields and encouraging the use of improved stoves so as to cut down costs of fuelwood access in the foreseeable future.

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Knowledge, attitude and practices of peasants towards hyraxes in two selected church forests in Tigray Region, Northern Ethiopia

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Church forests comprise local as well as global hotspots as critical conservation areas for a large portion of Ethiopian biodiversity. This study was conducted in two selected church forests based on presence of hyrax species and forest coverage in Tigray region, Northern Ethiopia to assess knowledge, attitude and practice (KAP) of peasants towards hyraxes in the church forests. Data collection was carried out from August, 2012 to January, 2013 using questionnaires' which contains both open and closed ended questions. The knowledge, attitude and practice of the local people towards the hyraxes and church forests were varied among the two church forests. Most respondents from Michael Tsilwo church forest had negative attitude towards the hyrax species although most respondents from Michael Romanat had positive attitude. The church forests have great contribution as habitat and source of food for the hyraxes in particular and many wild animals in general. Most of the local people living around the church forests do not seem to understand the ecological roles of the hyraxes and wildlife. Therefore, awareness creation programmes should be organized to the community and it will help to develop positive attitude towards hyraxes.

Key words: Attitude, church forests, hyraxes, interview, peasants, practice.

INTRODUCTION

Ethiopia is known for its topographical and biological diversity in Africa. It encompasses highly diverse flora and fauna. The country is endowed with diverse ecosystems and great varieties of habitats that contributed to the occurrence of diverse biological wealth of fauna, flora and microbial species (Yalden, 1983). According to Cole et al. (1994), 26 orders of living mammals are found in the world. Of these, 97.5% of the species occupy terrestrial habitat while the other 2.5% inhabit marine environments. Worldwide, 136 families 1,135 genera and 4,700 species of mammals are recorded (Cole et al., 1994; UNEP et al., 2009). Of the world's 4,700 mammal species, a quarter (1,229 species) occurs in Africa (UNEP et al., 2009). Large number of species of mammals including about 960 species and 137 species are found in sub-Saharan Africa and Madagascar, respectively. The eastern and southern savannahs also contain large number of mammals (UNEP et al., 2009).

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Ethiopia is also among the few African countries with high mammal species diversity (Yalden et al., 1996). It possesses a diverse mammalian fauna of 284 species of 52 families (Cole et al., 1994). In addition to mammalian species; other fauna of Ethiopia is also highly diversified with 861 species of birds, 201 reptiles, 150 fish, and 63 amphibians (Hillman, 1993). Out of these, 19 bird species, 40 fish species, 9 reptile species and 24 amphibian species are believed to be endemic to the country (Avibase, 2014; Hillman, 1993). However, attention given for conservation and sustainable use of these biodiversities is too little. Biodiversity of Ethiopia is under serious threat due to overexploitation, expansion of cultivation and settlements that are accompanied by excessive deforestation, overgrazing and pollution. As a result, distribution and population of many mammals of the country are dramatically declining (BIDNTF, 2010).

Mammals are important ecological components of all terrestrial ecosystems and they are important indicators of ecosystem health and integrity (Dirzo et al., 2009). However, because of lack of detailed information on the study of most of the mammals for instance in sub Saharan Africa, the current status, distribution and ecology of the mammal species is little known (Dirzo et al., 2009).

Hyraxes are medium-sized herbivorous terrestrial mammals, which belong to the order Hyracoidea, with short legs, a rudimentary tail, and round ears (Kingdon, 1997; Wossenseged Lemma, 2008). They are the smallest ungulate type mammals and they are alike in size and appearance to woodchuck or marmot (Estes, 1991). They are rabbit sized animals with very long bodies, blunt fingered hands, and feet, large mouthed, deep jawed and long fur. They have long and tactile hairs on their muzzle, cheeks, throat, brows, rump and limb joints (Kingdon, 1997).

Hyraxes play a crucial role in the ecosystem. They are described as umbrella and keystone species. As a result, they are used in conservation of other biodiversity in the environment. They also play an important ecological role in maintaining health of ecosystem, where they support a number of terrestrial and aerial predators as food supply. Hence, they influence the structure of the ecosystem (Chiweshe, 2007; Barry and Mundy, 1998). Hyraxes have ecological role in which they disperse seeds of plants and their waste products is used in localized nutrient cycling since it contains calcium carbonate. Hyrax middens are used as a high-resolution archives of long-term environmental change because it contain a great diversity of proxies including fossil pollen, stable isotopes, biomarkers, micro-charcoal, ancient DNA and phytoliths, thus readily enabling a multi-proxy approach to environmental reconstructions (Chase et al., 2012). Hyraxes have also direct importance to human beings. They are an important source of food in many parts of the world although it is not known in Ethiopia. For instance, species belonging to the genera of Procavia and Heterohyrax are source of protein for people living around in Matobo National Park in Zimbabwe (Chiweshe, 2007). Hyrax's meat is an important component of food in Yemen. It is the highest quality meat and source of income for people with low economic status in the country (Stevenson and Hesse, 1990). Hyrax's sticky solid called crystallized calcium carbonate is used as a medicine called hyraceum that is used to treat different diseases such as epilepsy and convulsions (Olds and Shoshani, 1982). On the other hand, hyraxes have negative effect to humans. Studies reported that the two species of hyraxes, P. capensis and H. brucei, are reservoir host of leishmaniasis (Wossenseged Lemma et al., 2009; Wossenseged Lemma, 2008). According to Moran et al. (1987), hyraxes also damage crops in some parts of the world.

Hunting, snaring, forest degradation and habitat loss are likely to threaten populations of many mammal species (Cordeiro et al., 2005). In the past several decades, wildlife populations in Ethiopia are under continuous threat due to deforestation, expansion of farmland, drought and illegal hunting (Melaku, 2011). The principal threat on hyraxes is likely to be human activity. In different localities of Africa, hyraxes are hunted for different purposes including medicine, food, and skin. They are caught in snares, extracted from their holes using a stick or forced from their trees by cutting or burning and then killing with spears or dogs (Topp-Jørgensen et al., 2008). Hyraxes are source of food through illegal poaching in different areas of the world (Chiweshe, 2007; Stevenson and Hesse, 1990). In addition to illegal killing they are also facing numerous threats by human activity such as road construction and habitat loss. In Jordan for instance, *P. capensis* are highly threatened by habitat degradation, through intensive farming, road construction and urban expansion (Rafai et al., 2000). Different studies showed disease, predation and drought are also causes for the decline of number of hyraxes (Barry and Mundy, 1998; Hoeck et al., 1982).

Survival of medium sized and large mammals is threatened by anthropogenic impacts such as habitat destruction and hunting (Dirzo et al., 2009). Similarly, the population of hyraxes is jeopardized by human activities including, habitat degradation, hunting and killing for different purposes, such as medicine, food, skin and ritual (Topp-Jørgensen et al., 2008; Rafai et al., 2000). Very little is known if the people practice the same in Ethiopia.

Mutually supportive relationships between communities and nearby wildlife are critical to the long-term success of conservation efforts (Anderson and Grove 1987 as cited in Sundufu et al., 2012). Understanding view of local people with respect to biodiversity and their attitude towards wildlife is very important to incorporate development goals into conservation practices (Tessema et al., 2010). Church forests comprise local as well as global hotspots as critical conservation areas for a large portion of Ethiopian biodiversity. In different parts of Ethiopia, in northern Ethiopia for example, the Ethiopian Orthodox Tewahido Churches are the predominant places where

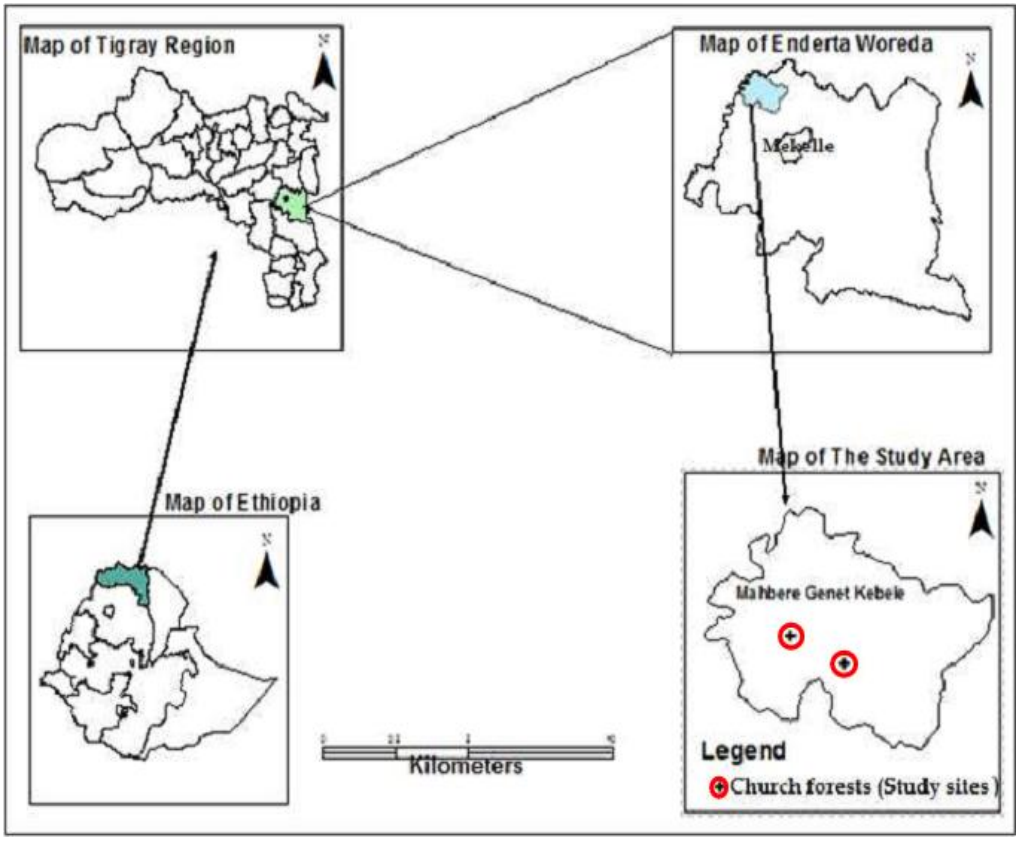

Figure 1. Map of the study area, showing map of Ethiopia (lower left), map of Tigray region (top left), map of Enderta Woreda (top right) and map of the study sites (right bottom).

patchy forested areas are left that contain several native plant species and several wildlife species, including mammals and birds (Colwell, 2010). As a result, hyrax species are found in some patchy forested areas of church forests. However, attitude of the peasants that live in and around the church forests towards the hyrax species, their knowledge on role of hyraxes in ecosystems and their practices in conserving of the church forests has not been reported in the region in particular and in Ethiopia in general as knowing attitude of peasants towards hyraxes is very crucial for the management and conservation plan of the animals. The present study, therefore, aimed to assess Knowledge, Attitude and Practice (KAP) of peasants towards hyraxes (*P. capensis* and *H. brucei*) in the selected church forests.

The two species of hyraxes are categorized as 'Least Concern' by the International Union for Conservation of Nature (IUCN) in its Red list category (Barry et al., 2008). However, populations of hyraxes are under threat throughout much of eastern and southern Africa, mainly due to habitat loss and illegal poaching. In order to conserve these species and prevent future decline, involving community based conservation practice is a must.

MATERIALS AND METHODS

Study area

The present study was carried out in two church forests in northern Ethiopia Tigray Province, Enderta Woreda. The two church forests (Michael Romanat and Michael Tsilwo) are selected from Enderta Woreda, Mahbere Genet kebele based on forest coverage and presence of hyraxes. The church forests lie between 13°34'54.1" and 13°34'81.2" latitude and 39°25'15.6" and 38°24'14.6"longitude, respectively (Figure 1). Michael Romanat church forest ranges in altitude from 1884 to 1914 and Michael Tsilwo church forest from 1778 to 1804 m.a.s.l. Mahbere Genet kebele is located about 23 km to the north west of Mekelle, the capital city of Tigray province, following the road that extends from Mekelle to Hagere Selam. Michael Romanat church forest covers an area of approximate 35,000 m^2 while Michael Tsilwo church forest has an area of approximate 40,000 m^2.

Rainfall and temperature data (2001 to 2012) were obtained from National Meteorological Agency, Mekelle branch. The mean monthly maximum temperature ranged between 22.4°C (December) and 27.4°C (June); whereas the mean monthly minimum temperature ranged between 9.17°C (January) and 13.8°C (May). According to the 12 years meteorological station data, mean annual rainfall of the area was 207.05 mm. The area has bimodal rainfall distribution characterized by prolonged wet season (main rainy season) from June to September locally known as "Kiremti" and short rainy season from April to May locally known as "Azmera". The driest season of the area is from December to February and it is locally

called “Hagay”.

The two church forests consist of various plant and animal species. The dominant plant species of Michael Romanat church forest are *Acacia* sp., *Olea europeae* and *Schinus molle* followed by a number of shrubs. The church forest also harbours different species of mammals such as bush hyraxes (*Heterohyrax brucei*), spotted hyena (*Crocuta crocuta*), common jackal (*Canis aureus*), porcupine (*Hystrix cristata*), ground squirrel (*Xerus rutilus* and *Xerus erythropus*), different species of birds such as owls and eagles and other amphibians and reptiles. *Brucea antidysenterica*, *Acacia etbaica*, *Arundo donax, Combretum molle*, *Rhus natalensis* and *Euclea racemosa* are dominant plant species in Michael Tsilwo church forest. In this church forest, different mammalian species such as rock hyraxes (*Procavia capensis*), spotted hyena (*Crocuta crocuta*), ground squirrel (*Xerus rutilus* and *Xerus erythropus*), porcupine (*Hystrix cristata*), several bird species such as eagles and buzzards and other amphibians and reptiles are found (Personal observation and local community by interview).

Data collection

This study was carried out from August, 2012 to January, 2013 for consecutive of six months. Semi-structured questionnaires were used to interview local people who live in and around the two churches to survey their knowledge, attitude and practices on the two species of hyrax and the church forests. The interview questionnaires were prepared first in English and then translated into local language, Tigrigna, for interview. Significance of the church forest for hyraxes and other wildlife, advantage and disadvantage of hyraxes for the community, role of hyraxes for ecosystem were some of the questions. Questions related to their attitude towards the church forest and conservation of the hyraxes, their practices in conserving the plants and animals in the church forests and other open and close ended questions were raised to the local people. In each of the two churches (study sites), a total of 60 local people regularly attending the churches were interviewed. Data collected from the field were analyzed using MiniTAB 14 computer software programme and Microsoft Excel.

RESULTS

Knowledge, attitude and practice (KAP) survey

Michael Tsilwo church forest

The result of the KAP survey of local people living in and around Michael Tsilwo church forest, concerning *P. capensis* and the church forest is showed in Table 1. A total of 60 respondents were interviewed: elder males (33.3%), elder females (33.3%), priests (16.7%) and youth (16.7%), which composed of 60% females and 40% males. The age of the respondents ranged from 25-73 years. All the respondents were from “Kushet Tsilwo” the nearest village to the church forest.

Forty percent of the respondents revealed that *P. capensis* are the most common wild animals in the church forest (Table 1). Some of the respondents also mentioned that birds (30%) are the dominant animals in the church forest. Regarding the importance of hyraxes to the community around the church forest, most of them (63.3%) said that they have no benefit to them. On the other hand, when they were asked about the negative effects of the hyraxes to the community, 30% of the respondents reported that the hyraxes damage crops while the majority of the respondents (86.7%) do not scare the hyraxes in the church forest, few of them (13.3%) do scare hyraxes while 40% of the respondents revealed that the abundance of *P. capensis* has increased in this church forest since the last five years, 10% of the respondents reported that the abundance of the animals has decreased. When asked regarding the habitat of *P. capensis*, most of them (70%) responded that rocky outcrops were the most preferred habitat. Concerning predators, 36.7% of the respondents believed that eagles were the most common predators of the hyraxes, followed by domestic dogs (16.7%).

Good proportion of the respondents (40%) reported that *Olea europaea* was the predominant source of food for the hyraxes in the church forest, followed by grasses (30%). When asked the distribution or presence of the animals in their residential area (out of the church forest), 86.7% of the respondents reported that they are absent. Large proportion of the respondents (56.7%) had negative attitude towards hyraxes. In contrast, few of the respondents (16.7%) had positive attitude. Majority of the respondents (70%) reported that the status (size and vegetation cover) of church forest has improved in the last five years. On the other hand, 20% of the respondents indicated that the status of the church forest has not changed in the last five years.

Most of the respondents (53.3%) believed that currently the church administrators are providing protection of the church forest. On the other hand, 16.7% of them said that all the communities around the church are protecting the church forest. 16.7% of the respondents have previously participated in planting seedlings and protections of the church forests. In contrast, large proportion of the respondents (60%) never participated in protection of the church forest. Majority of the respondents (93.3%) said that they don’t care for conservation of wildlife in the church forest, whereas 6.7% of the respondents have participated in conservation of resources of the church forest (for example, planting seedlings and guarding the forest).

Michael Romanat church forest

The result of the KAP survey of local people living in and around Michael Romanat church forest, concerning *H. brucei* and the church forest is showed in Table 2. A total of 60 respondents were interviewed in this church forest: elder males (33.3%), elder females (33.3%), priests (16.7%) and youth (16.7%), composed of females (40%) and males (60%). The age of the respondents ranged from 27-70 years. All the respondents were from “Kushet Romanat”, the nearest village to the church forest. Out of the respondents interviewed in the church forest, many of those (53.3%) reported that birds were common observed wild animals. 23.3% of the questionnaire

Table 1. Knowledge, Attitude and Practice survey of local people living in and around Michael Tsilwo church forest, concerning *P. capensis* and the church forest.

Interview questions	Responses			
	Number (%)			
Most common animals in the church forest	Hyraxes 24(40%)	Birds 18(30%)	Hyenas 12(20%)	Porcupines 6(10%)
Purpose of hyraxes for people	Nothing 38(63.3%)		Do not know 22(36.7%)	
Negative effect of hyraxes	No effect 34(56.7%)	Crop damage 18(30%)	Do not know 8(13.3%)	
Do you scare hyraxes when you see them	No 52(86.7%)	Yes 8(13.3%)		
Situation of number of hyraxes in the last five years in the church forest	Increased 24(40%)	Decreased 6(10%)	No change 12(20%)	Do not know 18(30%)
Habitat of hyraxes	Rocky outcrops 42(70%)	Under stones 14(23.3%)	Boulder piles 4(6.7%)	
Potential predators for the hyraxes	Eagles 22(36.7%)	Hyenas 2(3.3%)	Domestic dogs 10(16.7%)	Do not know 26(43.3%)
Source of food for hyraxes	Grass 18(30%)	*Olea europaea* 24(40%)	*Acacia etbaica* 6(10%)	*Combretum molle* 12(20%)
Are hyraxes found in your residential area (out of the church forest)	No 52(86.7%)	Yes 8(13.3%)		
Importance of church forest for hyraxes	Shelter (habitat) 44(73.3%)	Protect from predator 10(16.7%)		Do not know 6(10%)
Your attitude towards hyraxes	Positive 10(16.7%)	Negative 34(56.7%)		No idea 16(26.7%)
Negative effect of hyraxes on the church or on the forest	No effect 46(76.7%)	Do not know 14(23.3%)		
Status of the church forest in the last five years	Increased 42(70%)	No change 12(20%)		Do not know 6(10%)
Who protect the church forest	All community 10(16.7%)	Church administrator 32(53.3%)		Priests of the churches 18(30%)
Your role in protecting the church forest	Planting and protecting 10(16.7%)	Protecting the forest 14(23.3%)		Nothing 36(60%)
Your role in protecting animals of the church forest		Try to protect 4(6.7%)	Do not care 56(93.3%)	

Table 2. Knowledge, attitude and practice survey of local people living in and around Michael Romanat church forest, concerning *H. brucei* and the church forest.

Interview questions	Responses			
	Number (%)			
Most common animals in the church forest	Birds 32(53.3%)	Hyraxes 14(23.3%)	Hyenas 8(13.33%)	Jackals 6(10%)
Purpose of hyraxes for people	Nothing 46(76.7%)	Traditional medicine 4(6.7%)	Do not know 10(16.7%)	
Negative effect of hyraxes to the community	No effect 54(90%)	Do not know 6(10%)		
Do you scare hyraxes when you see them	Yes -	No 60(100%)		
Situation of number of hyraxes in the last five years	Decreased 26(43.3%)	No change 16(26.7%)	Do not know 18(30%)	
Habitat of hyraxes	Forest 30(50%)	*Olea europea* 12(20%)	*Mimusops kummel* 10(16.7%)	*Acokanthera schimperi* 8(13.3%)
Potential predators	Eagles 26(43.3%)	Owls 22(36.7%)	Do not know 12(20%)	
Source of food for hyraxes	*Carissa spinarum L.* 22(36.7%)	*Olea europea* 18(30%)	*Acokanthera schimperi* 10(16.7%)	Do not know 10(16.7%)
Hyraxes in your residential area (out of the church forest)		No 48(80%)	Yes 12(20%)	
Important of church forest for hyraxes		Shelter (habitat) 48(80%)	Protect predator 2(3.3%)	Do not know 10(16.7%)
Your attitude towards hyraxes		Positive 32(53.3%)	Negative 10(16.7%)	No idea 18(30%)
Negative effect of hyraxes on the church or on the forest		No effect 52(86.7%)	Do not know 8(13.3%)	
Status of the church forest in the last five years		Increased 50(83.3%)	No change 6(10%)	Do not know 4(6.7%)
Who protect the church forest		All community 18(30%)	Church administrator 36(60%)	Priests of the churches 6(10%)
Your role in protecting the church forest		Planting trees and protecting 6(10%)	Protecting 30(50%)	Nothing 24(40%)
Your role in protecting animals of the church forest		Protecting 24(40%)		Do not care 36(60%)

respondents also revealed that hyraxes were commonly observed animals in the church forest. Large proportion of respondents (76.7%) confirmed that hyraxes have no any positive value for communities around the church forest. In contrast, very few interviewees (6.7%) said that they are used as traditional medicine. Negative effect of hyraxes to the communities was also interviewed to the local people. Then most of the respondents (90%) said that they don't have negative effect. All the respondents don't scare hyraxes on the church forest.

Regarding the status of *H. brucei* in the last five years, nearly half of the interviewees (43.3%) confirmed that the abundance of *H. brucei* has decreased. In contrast, 26.67% of the interviewees believed that the abundance of *H. brucei* in the church forest has no change. Half of the interviewees reported that *H. brucei* live in the church forest (they did not list the species of the plants) while 20% of them listed that *O. europaea* was used as habitat. Among the interviewees, 20% reported that hyraxes are found in their residential area (out of the church forest).

Large proportion of the respondents (80%) believed that the church forest is used as habitat for hyraxes. In contrast, 16.7% of the respondents do not know significance of the church forest for hyraxes. Majority of the questionnaire respondents (53.3%) had positive attitude towards hyraxes, whereas 16.67% of them had negative attitude. When asked regarding the status of church forest in the last five years, most of the respondents (83.3%) believed that the church forests has increased and 6.67% of them do not know the status of the church forest. Large proportion of the respondents (60%) believed that currently the church administrators are providing protection for the church forest. But, 30% of them reported that all the communities around the church are protecting the church forest.

Out of the respondents, half of them have previously participated in planting and protection of the church forest and 10% of them have participated both in planting seedlings and protecting the church forest. On the other hand, 40% of the respondents do not care for planting seedlings and protecting the church forest. Most of the questionnaire respondents (60%) do not care for the wildlife found in the church forest. In contrast, 40% of the interviewees try to care in conserving of the animals. The some of the interviewees recommended that the government should give attention to the church forest and it should have permanent guards in order to conserve wildlife of the church forest.

DISCUSSION

Michael Tsilwo church forest

From the result of this study, most respondents in the study area reported that hyraxes were the most common animals in the church forest. They believed that female hyraxes give several young ones and is the reason for dominance of the hyraxes as to what becomes the commonest of the animals. The respondents indicated also that the church forest is home to many other wild animals including hyena, common jackal, birds and porcupine. They revealed that it is due to the fact that people do not disturb/kill the animals in the church forest, compared to for instance other places around the village because the people believe killing animals in the vicinity of the church is sin. According to most of the respondents, the hyraxes never give any value to the community. In contrast, several researchers (Chiweshe, 2007; Rifai et al., 2000; Stevenson and Hesse, 1990) from Zimbabwe, Jordan and Yemen, respectively reported that meat of *P. capensis* is a source of food to local communities.

During the present study, some respondents reported that *P. capensis* damage crops around the church forest. Similar negative effect has been reported by Moran (1996) from Israel who observed hyraxes causing damage to fruit trees such as avocado (*Persea americana*), persimmon (*Diospyros kaki*) and mango (*Mangifera indica*). The present result showed that very few respondents scare hyraxes. Peoples who scare the hyraxes were those who have farmland near the church forest because they believed that the hyraxes damage their crops.

Some of the respondents stated that the abundance of hyraxes in the church forest has risen in the last five years and few believed that abundance has dropped, although they did not describe factors for the decrease in the abundances. Few of the respondents reported that domestic dogs, particularly those that come to the church with the people praying there hunt the hyraxes. According to the majority of the respondents, hyraxes do not inhabit the residential area of the local people. This could be due to availability of food and a stability of the area from human disturbances. Distribution and diversity of medium and large-sized mammals is associated with the presence of food and water and stability of their habitat from disturbances (Meseret, 2010). The current collection of stones from the habitat of *P. capensis* for renovation of the church as well as the newly stated road construction close by may result destruction of their habitats which may lead to local extinction of the species. Furthermore, these habitat destruction activities and the ongoing frightening of the animals by local people may force the animals to migration. Habitat destruction such as road construction, frighten animals and create noise lead to changes in species composition (Blumstein, 2010).

Michael Romanat church forest

More than half of the respondents reported that common observed animals in this church forest are different variety of birds. However, few of them reported hyraxes are common animals. According to most respondents, local peoples never benefit from hyraxes. However, studies in Matobo hills of Zimbabwe indicated that *H. brucei* are

main source of protein to the local people (Chiweshe, 2007). Though, very few respondents use hyraxes as traditional medicine, they reported that it was difficult to kill the hyraxes. Based on the present findings, good proportion of the interviewees reported that the status of hyraxes has decreased in the last five years, but they did not know the factor for decreasing of the animals.

Very few of the interviewees, reported that hyraxes are distributed in their residential area as to ask the distribution of hyraxes out of the church forest. However, they confirmed that these hyraxes are different from the hyraxes that are found on the church forest both in color and habitat. These hyraxes could be *P. capensis*. More than half of the respondents of Michael Romanat church forest had positive attitude towards hyraxes. Reason given for positive attitude of hyraxes includes attract tourists, and generate income for the church. Positive attitude of local community towards wildlife has been reported by Tessema et al. (2010) who assessed attitude of community toward wildlife and protected areas in four National parks of Ethiopia. On the other hand, 46.7% of the respondents didn't know ecological value of hyraxes. This may be due to lack of awareness on the wild animals.

Conclusion and Recommendations

Based on the responses of peasants, the population status of *H. brucei* has been declining while the population status of *P. capensis* has been increasing in the last five years. Majority of the respondents had positive attitude towards the church forests. However, it has been for the sake of the church that they believe that cutting plants from the church compound is forbidden. Most local people do not seem to have concern about the hyraxes and few respondents from Michael Tsilwo church forest have positive attitude towards the hyraxes. The church forests have great contribution as habitat and source of food for the hyraxes in particular and many wild animals in general although the main purpose of the churches is worshiping.

Most of the peasants do not seem to understand the ecological roles of the hyraxes and wildlife. Therefore, awareness creation programmes should be organized to the community. The awareness creation campaign should also focus on teaching the community and the effect of hunting by domestic dogs on the hyrax population is appreciated for conservation of the species. In order to increase the number of people who have a positive attitude towards hyraxes, the responsible bodies might work to benefit the local community and to increase their awareness. Based on reports of the local people and personal observation; these church forests are containing various wild animals. So, regular assessment and monitoring of other wild animals should be conducted in the church forests. Moreover, possible solutions should be taken to reduce/stop livestock grazing in the church forests.

Conflict of interests

The authors did not declare any conflict of interest.

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Selected wild plant species with exotic flowers from Jordan

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The flora of Jordan with regards to the flowering vascular plant represents a high diversity in such a semi-arid country like Jordan which is part of the Eastern Mediterranean region. In this study, a number of 59 wild species with showy, exotic flowers from Jordan are illustrated; the selected species are not introduced or cultivated but rather local wild flowers selected for their showy, colorful flowers and for their medicinal, edible and ornamental values. Most of the recorded species in this study are endangered and exposed to degradation. The selected plant species are ornamental, showy with colorful flowers like *Orchids, Irises*, *Crocuses, Narcissus*, *Cyclamen*, *Ixiolirion, Linum*, *Anemone*, *Salvias, Sternbergia* and *Ornithogallum.* Some of the illustrated plant species are endemic to Jordan like: *Iris nigricans* which is the national flower of Jordan, *Crocus moabiticus*, *Iris edomensis* and *Iris petrana*, many plant species are demonstrated for their medicinal values like *Achillea fragrantissima*, *Arum palestinum*, *Glaucium arabicum, Erodium gruinum*, *Alcea setosa*, *Hyoscyamus reticulatus* and others. Other species are mentioned for their edible consumption like *Capparis spinosa*, *Cretaegus aronia, Crocus hermoneus, Cyclamen persicum*, *Gundelia tournefortii*, *Lupinus varius*, *Malva setosa* and others. Photographs are demonstrated for most of the selected plants.

Key words: Exotic flowers, wild flowers, Jordan.

INTRODUCTION

Some plants produce showy, colorful, exotic flowers, and they are not considered exotic by definition, because exotic plants literally means “foreign” or anything unusual or extraordinary” (Morton, 1977), another definition for exotics is “from elsewhere” (Kepler, 1996). The exotics or extraordinary plants have been illustrated by Patrick and Arnold (2000), where they presented 300 selected extraordinary plant species from all over the world, exotic plants of Bahrain were described by Shaheen (2003), who recorded 345 perennials and annual plant species in the area of her garden in Bahrain.

Flora of Jordan is highly diversified in its number of vascular, flowering plants. A number of 2078 species was recorded by (Al-Eisawi, 1982), this number had been revaluated in the new checklist by (General Corporation for Environmental Protection and Al-Eisawi (2000) and a

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Table 1. Names, families, species potential (M, Ed, or), remarks, habitat and geographical distribution.

Scientific name	Family	Potential (M, OR)	Remarks, habitat and geographical distribution
Acanthus syriacus L.	Acanthaceae	OR	Red soil. Stony ground. Ajloun, Jarash, Irbid, Madaba, Salt.
Achillea fragrantissima (Forssk.) Schultz Bip.	Asteraceae	M, OR	Desert, dry places. Eastern desert, Wadi_Rum, Aqaba, Dead_Sea, Tafilah, Karak, Madaba, Mafraq.
Alcea refescens (Boiss.) Boiss.	Malvaceae	M, OR, Ed	Wadis. Wadi Mujib, Dead Sea.
Alcea setosa (Boiss.) Alef. (Feinbr.)	Malvaceae	M, OR	Road sides. Irbid, Amman, Karak, Tafilah, Salt, Amman, Ajloun.
Allium truncatum Kollmann & D. Zohary	Amarylidaceae	M, OR	Waste fields, road sides. Tafilaf, Karak, Amman, Madaba, Salt, Irbid.
Anemone coronaria L.	Ranaculaceae	OR, M	Waste lands, mountains. Ajloun, Irbid, Jarash, Madaba, Karak, Tafilah.
Anthemis palaestina Reuter	Asteraceae	M, OR	Waste fields . Jordan Valley, Irbid, Jarash, Salt.
Arum palaestinum Boiss.	Araceae	M, OR, Ed	Mountains and rocky grounds. Amman, Salt, Ajloun, Irbid, Jarash.

number of 2500 species has been recorded in this new checklist. New publications were made for flora of Jordan in different geographical areas like Tafilah county in the south was published by (Oran, 2014), a number of plant species recorded in this recent study were also listed in Tafilah area with some exotic plants; The field guide to wild flowers of Jordan and neighboring countries by (Al-Eisawi, 1998), the book is including 488 colored plant species, many of which are exotic or with showy flowers. A taxonomic revision for the orchids of Jordan which is most exotic flowers was published by (Al-Eisawi, 1986); some showy flowering plant species were included. Lots of research has been done on the biological potentials of medicinal plants in Jordan ethnobotanical survey of the medicinal plants in the central mountains (North-South) in Jordan by (Oran and Al-Eisawi, 2015).

Some of the recorded species in this study are wild plants with showy flowers like *Lupinus*, *Ixiolirion*, *papaver*, *Sternbergia*, *Linum* and others. This article aimed to present some selective showy, ornamental, colorful, wild plant species and their photographs. The plant species are chosen for their showy colorful flowers, their biological and ornamental potentials, as well as habitat and geographical distribution. Table 1 and Figure 1a to o show the potential of each plant species included in this study, those plants with medicinal values are given abbreviation such as M, ED for edible plants and those with ornamental potential are abbreviated with OR (Table 1).

MATERIALS AND METHODS

Plant specimens were collected, processed and identified by plant taxonomist Sawsan Oran, professor of plant taxonomy; by using the related flora of the region. Photographs were taken for plant species from different geographical areas in Jordan; they were identified by plant taxonomists, and checked using IPNI system. Voucher specimens were deposited at the herbarium allocated at the Department of Biological Sciences at the University of Jordan in Amman (AMM). Scientific names of the selected plants are given in Table 1. Photographs for the available plant species with showy, exotic flowers were taken by the author as shown in (Figure 1a to o).

RESULTS

Fifty nine (59) species of flowering plants with selected showy, exotic flowers are shown in this manuscript for the following plant species: *Orchis anatolica, Ophrys lutea, Narcissus tazzetta, Sternbergia clusiana, Crocus moabticus, Crocus hermoneus, Crocus hyamalis,*

Table 1. Contd.

Asphodeline lutea (L.) Reichenb.	Liliaceae	M, OR	Waste high water. Amman, Ajloun, Irbid, Salt, Ras Al-Naqab.
Asphodelus aestivus Brot.	Liliaceae	M, OR	Waste mountainous areas. Amman, Ajloun, Jarash, Salt, Madaba, Karak, Tafilah.
Calycotome villosa (Poiret) Link	Rosaceae	OR	Mountains and rocks.
Capparis spinosa L.	Capparaceae	M, OR, Ed	Flower buds edible.
Cichorium pumilum Jacq.	Asteraceae	M, OR	Waste high mountains. Amman, Salt, Irbid, Jarash, Ras Al-Naqab.
Cistus creticus L.	Cistaceae	M, OR	Forests, mountains. Amman, Ajloun, Irbid, Salt.
Cistus salvifolius L.	Cistaceae	M, OR	Forests, mountains. Amman, Ajloun, Jarash, Irbid, Salt.
Colchicum hierosolymitana Feinbr.	Liliaceae	M, OR	Mountains, rich soil. Amman, Salt.
Convolvulus althaeoides L.	Convolvulaceae	M, OR	Road sides. Amman, Irbid, Jarash, Karak, Tafilah, Mafraq.
Cretaegus aronia (L.) Bosc. ex DC.	Rosaceae	M, OR, Ed	Mountains, forests. Amman, Jarash, Irbid, Ajloun, Salt, Karak, Tafilah.
Crocus hermoneus Ky. ex Maw subsp. palaestinus Feinbr.	Iridaceae	M, OR, ED	Mountains. Amman, Salt, Jarash,
Crocus hyamalis Boiss. & Blanche	Iridaceae	M, OR, ED	Forests, red soil. Ajloun, Jarash.
Crocus moabiticus Bornm. & Dinsm. ex Bornm.	Iridaceae	M, OR, ED	Endemic. Desert Petra, Dab'a.
Cyclamen persicum Miller	Primulaceae	M, OR, ED	Mountains, forests. Amman, Ajloun, Irbid, Salt, Karak, Tafilah.
Eremostachys laciniata (L.) Bunge	Lamiaceae	M, OR	Road sides. Amman, Ajloun, Irbid, Karak, Tafilah.
Erodium gruinum (L.) L'He'r.	Geraniaceae	M, OR, Ed	Waste places. Ajloun, Irbid, Jarash, Salt, Karak, Tafilah, Shoubak.
Gladiolus atroviolaceous Boiss.	Iridaceae	OR	In the farms and fields. Amman, Irbid, Madaba, Mafraq,Tafilah.
Glaucium arabicum Fresen.	Papaveraceae	M, OR	Semi dry areas. Amman, Irbid, Salt, Madaba, Tafilah, Karak, Shoubak.

Table 1. Contd.

Gundelia tournefortii L.	Asteraceae	M, OR, ED	Flower buds edible. Road sides, waste lands. Amman, Jarash, Irbid, AjlounMadaba, Karak, Tafilah.
Himantoglossum capricum	Orchidaceae	M, OR	Forests. Salt, Jarash.
Hyoscyamus reticulatus L.	Solanaceae	M, OR	Fields. Amman, Irbid, Jarash, Karak, Madaba Tafila.
Iris aucheri (Baker) Sealy	Iridaceae	OR	Rare. Desert. Eastern desert.
Iris bismarckiana Regel	Iridaceae	OR	Rare. Forests. Amman, Jarash.
Iris edomensis sealy	Iridaceae	OR	Endemic. National flower of Jordan.
Iris nigricans Dinsm.	Iridaceae	M, OR	Mountains, marginal fields. Amman, madaba, Karak.
Iris petrana Dinsm.	Iridaceae	M, OR	Endemic. Petra, Shoubak, Tafilah.
Iris regis-auzziae Feinbr.	Iridaceae	OR	Rare. Yellow soil. Ras al-Naqab.
Iris vartanii Foster	Iridaceae	OR	Rare. Mountains Salt.
Ixiolirion tataricum (Pallas) Herb.	Amarylidaceae	OR, M	Mountains, fields. Amman, Ajloun, Jarash, Karak, Tafila.
Linum mucronatum Bertol.	Linaceae	M, OR, ED	Mountains. Amman, Ajloun, Jarash, Salt,
Linum pubescens Banks & Sol.	Linaceae	M, OR, ED	Mountains. Amman, Ajloun, Irbid, Jarash, Madaba.
Lonicera etrusca Santi	Caprifoliacea	M, OR	Forests. Amman, Ajloun, Irbid, Jarash, Salt, Tafilah.
Lupinus varius L.	Fabaceae	M, OR, Ed	Rare. Mountains. Irbid, Salt.
Alcea setosa (Boiss.) Alef.	Malvaceae	M, OR	Fields, road sides. Amman, Ajloun, Jarash, Irbid, Salt, Karak, Tafila.
Malva sylvestris L.	Malvaceae	M, OR, Ed	Road sides, fields. Amman, Ajloun, Jarash, Madaba, Karak, Tafilah.

Table 1. Contd.

Muscari commutatum Guss.	Iridaceae	OR	Mountains. Amman, Karak, Shubak, Mafraq.
Narcissus tazetta L.	Iridaceae	OR	Rare. Mountains. Amman, Salt.
Ononis natrix L.	Fabaceae	M, OR	Road sides. Amman, Ajloun, Irbid, Madaba, Salt, Karak, Tafilah.
Orchis anatolica Boiss.	Orchidaceae	M, OR	Rare. Forests. Amman, Ajloun, Jarash, Salt.
Ophrys lutea (Gouan) Cav.	Orchidaceae	M, Or	Rare. Forests. Ajloun, Jarash.
Ornithogalum montanum Cyr.	Liliaceae	OR, M	Mountains. Amman, Ajloun, Jarash, Salt.
Ornithogalum sp.	Liliaceae	OR	Mountains, Fields. Amman, Ajloun, Irbid, Jarash, Salt.
Papaver syriacum Boiss. & Blanche	Papaveraceae	M, OR	Mountains and deserts. Amman, Jarash, Irbid, Karak, Tafilah.
Pyrus syriaca Boiss.	Rosaceae	M, OR, ED	Forests. Amman, Jarash, Ajloun, Salt.
Rubus sanguineous Friv.	Rosaceae	M, OR, ED	Fields, sides of water canals. Amman, Salt, Tafila, Al-Hemmeh.
Salvia hierosolymitana Boiss.	Lamiaceae	M, OR, ED	Fields. Amman, Jarash, Salt, Irbid, Ajloun, Tafilah.
Salvia palaestina Bentham	Lamiaceae	M, OR	Fields, road sides. Amman, Salt, Jarash, Irbis, Tafilah.
Scolymus maculatus L.	Asteraceae	OR	Fields Amman, Ajloun, Jarash, Irbid, Karak.
Senecio vernalis Waldest. & Kit.	Asteraceae	OR	Common. Fields, mountains. Amman, Ajloun Irbid, Jarash, Salt, Jordan Valley, Karak, Tafila.
Sternbergia clusiana Ker-Gawler	Amarylidaceae	M, OR	Rare. Mountains. Amman, Salt, Jarash Karak, Ras Al-Naqab.
Tulipa stylosa Stapf	Iridaceae	OR, M	Rare. Mountains, marginal lands. Amman, Salt, Shoubak, Ras Al-Naqab.

M, Medicinal; OR, ornamental; ED, edible.

Crocus hermoneus

Crocus moabiticus

Crocus hyemalis

Cistus creticus

Cistus salvifolius

Figure 1a. Exotic Plants in Jordan (Photographed by Sawsan Oran).

Rubus Saguineus with fruits

Rubus sanguineous in flowers

Cyclamen persicum

Sternbergia Clusiana

Figure 1b. Exotic Plants in Jordan.

Tulipa stylosa *Lupinus varius*

Ornithogalum montanum *Senecio vernalis*

Figure 1c. Exotic Plants in Jordan.

Iris edomensis Sealy *Iris nigricans* Dinsm

Iris petrana Dinsm *Iris regis-uzziae* Feinbrn

Figure 1d. Exotic flowers from Jordan.

Iris aucheri (Baker) sealy

Iris bismarckiana Regal

Narcissus tazetta L.

Acanthus syriacus Boiss

Figure 1e. Exotic flowers from Jordan.

Eremostachys laciniata (L.) Bunge

Ophrys lutea (Gouan) Cav.

Orchis anatolica Boiss

Ononis natrix L.

Figure 1f. Exotic flowers from Jordan.

Anemone coronaria L.

Papaver syriacum Boiss & Blanche

Convolvulus althaeoides L.

Colchicum hierosolymitanum Feinbr

Figure 1g. Exotic flowers from Jordan.

Capparis spinosa L.

Ixiolirion tataricum (Pallas) Herb

Malva sylvestris L.

Scolymus maculatus L.

Figure 1h. Exotic flowers from Jordan.

Anthemis palaestinum Reuter

Crataegus aronia (L.) Bosc. ex DC.

Arum palaestinum Boiss

Cichorium pumilum Jacq.

Figure 1i. Exotic Plants from Jordan.

Linum pubescens Banks & Sol

Muscari commutatum Guss

Gladiolus atroviolaceus Boiss

Glaucium arabicum Fresen

Figure 1j. Exotic flowers from Jordan.

Asphodelus aestivus Brot.

Asphpdeline lutea (L.) Reichenb.

Allium truncatum (Feinbr.) Kollmann & Zohary

Hyoscyamus reticulatus L.

Figure 1k. Exotic flowers from Jordan.

Alcea rufescens (Boiss.) Boiss.

Alcea setosa (Boiss.) Alef.

Salvia hierosolymitana Boiss.

Salvia palaestina Bentham

Figure 1m. Exotic flowers from Jordan.

Gundelia tournefortii L.

Linum mucronatum Bertol.

Achillea fragrantissima (Forskal) Schultz Bip.

Figure 1n. Exotic flowers from Jordan.

Erodium gruinum (L.) L'He'r.

Ornithogallum sp.

Calycotome villosa (Poiret) Link

Lonicera etrusca Santi

Figure 1o. Exotic flowers from Jordan.

Anthemis palestinum, Linum pubescens, Linum macronatum, Iris nigricans, Iris bismarckiana, Iris vartanii, Iris regis-auzziae, Iris edomensis, Iris petrana, Iris aucheri, Eremostachys laciniata, Cyclamen persicum, Anemone coronaria, Ixiolirion tataricum, Tulipa stylosa, Lupinus varius, papaver syriacum, Capparis spinosa, Cichorium pumilum, Salvia hierosolymitana, Salvia palestina, Calycotome vilosa, Colchicum hierosolymitanum, Malva sylvestris, Gundelia tournefortii, Ononis natrix, Senecio vernalis, Acanthus syriacus, Cistus creticus. Cistus salvifolius, Ornithogallum montanum, Ornithogallum laciniatum, Muscari commutatum, Allium truncatum, Himanthoglossum caprinum, Asphodeline lutea, Gladiolus atroviolaceous, Asphodelus aestivus, Glaucium arabicum Hyoscyamu reticulatus, Pyrus syriaca, Crataegus aronia, Achillea fragrantissima, Malva sylvestris, Arum palaestinum, Rubus sanguineus, Convolvulus althaeoides, Scolymus maculatus, Alcea setosa, Alcea rufescens, Erodium gruinum and *Lonicera etrusca* (Table 1 and Figure 1a to o).

DISCUSSION

The recorded plant species included in this article represents selected wild plant species from flora of Jordan with showy, colorful flowers of medicinal, ornamental or edible values. The photographs are shown for some selected plant species belonging to different families and different genera, and species from one or different families of vascular flowering plants. The shown photographs represent a variety of colorful species, with different biological potentials. Some are considered to have medicinal values that can be used in folk medicine or can be implemented in pharmaceutical industry, for example, *Lupinus*, *Ixiolirion*, *Salvia*, *Calycotome*, *Irises* species as well as *Narcissus, Ornithogallum, Sternbergia* and other mentioned species (Oran et al., 1998); some recorded species can be that with ornamental flowers like *Anemone*, *Papaver, Orchids*, *Cyclamen*, *Sternbergia* and others; other species are edible plants like *G. tournifortii, C. aronia, Capparis spinosa, M. setosa* and some others (Tukan et al., 1998). However, the aim of this work was to focus on some wild plant species that have exotic or showy flowers, or for their medicinal, ornamental and edible interests. Most of the mentioned plant species are endangered and serious measures should be implemented for conservation and protection of such valuable wild flowers.

Conflict of interests

The authors did not declare any conflict of interest.

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