

# Watershed Disturbance and its Potential Effects on River Systems in the Okyeman Traditional Area of Ghana: The Case of Atewa Range Forest Reserve

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## Abstract

The Atewa Range Forest Reserve in the Eastern Region of Ghana is a very important watershed which serves three important river systems - the Densu, Ayensu and Birim, all in southern Ghana. Widespread degradation of the forest reserve as a result of rampant anthropogenic activities threatens the long-term sustainability of these water bodies. The study examined local dependence on products from the forest reserve and its effects on the watershed with the view to highlighting the magnitude of the exploitation in order to inform policy makers and planners on the need to protect this strategic watershed. Data for the study was collected through literature search and questionnaire administration of seven communities involving 76 respondents within the vicinity of the reserve. The findings revealed that not only do the local people exploit the Atewa Range Forest Reserve products like timber, fuel wood and bushmeat for home consumption but they also trade in these products. Incomes derived from the sale of forest products in the seven communities within a year was estimated at US\$ 84,014.22 which is very significant. The findings also revealed that a major reason for the high local dependence on the reserve is the demand pressure not only from the neighbouring communities but the travelling public who patronize the forest product from hawkers by the roadside. The study concluded by reiterating the strategic importance of the Atewa Range Forest Reserve as a watershed, and suggested the need for all concerned to protect it against all forms of disturbance.

## Introduction

Resource exploitation within watershed areas constitutes substantial disturbance to streams and water bodies within the catchment of the watershed. Such disturbances affect hill slope run-off, ground water recharge, stream flow, sediment loads, stream turbidity and general water quality within river systems (Keim *et al.*, 2006, Smerdon *et al.*, 2009, de Vries and Simmers, 2002). Undisturbed watersheds with sufficient forest cover tend to be dominated by sub-surface flow as a result of high infiltration capacity and reduced erosion due to protective vegetation cover (Winkler *et al.*, 2009, Butterworth *et al.*, 1999). For every eco-system, disturbances are short-lived, and recoverable in the absence of

further disturbance (Webster *et al.*, 1988). Streams however exhibit relatively low resistance to disturbance because they serve as receptacles for most of the upstream activities. In essence, the consequences of watershed disturbance on water courses can be long-term, often lasting as long as full recovery of watershed vegetation to pre-disturbance structure and function (Webster *et al.*, 1988). Watershed protection is therefore very crucial for the maintenance of aquatic ecosystems within the catchment. This study focuses on Atewa range watershed, which has undergone widespread degradation as a result of human activities.

Atewa mountain range, in the Okyeman Traditional Area of the Eastern Region of

Ghana, peaks at 842 (m.a.s.l.) and runs roughly from north to south. It is characterized by a series of plateaus which are remnants of a Tertiary peneplain (McCullough *et al.*, 2007). The mountain range lies within two climatic zones: the dry and the wet semi-equatorial transition zone, with average temperatures between 24°C and 29°C. Mean annual rainfall is between 1200 and 1600mm. The vegetation within the mountain range is very diverse with elements of upland evergreen forest, moist semi-deciduous forest, transitional climatic zone and thicket vegetation as a result of human activities (McCullough *et al.*, 2007).

It is an important watershed from where three important rivers namely the Densu, Ayensu and Birim take their sources (Fig. 1). These three rivers are the most important source of domestic and industrial water for local communities within their respective catchments including Accra, the capital of Ghana. Since 1926, the range has been protected as forest reserve (McCullough *et al.*, 2007), and has since remained as one of the largest forest reserves in the country, with an area of 23,663 ha.

Atewa Range Forest Reserve is not only recognized as a watershed but also known to constitute the largest and most intact patch of upland evergreen forest in Ghana, representing at least 75% of this habitat type countrywide. This forest reserve is distinguished by one of the highest levels of biodiversity in Ghana, including black star plant species and several endemic butterfly species like *N. lamborni* and *B. auricruda*. (Hawthorne, 1998; Larsen, 2006; McCullough *et al.*, 2007; Rapid Assessment Program, 2007). The reserve represents about

33.5% of the remaining closed forest in Ghana's Eastern Region and one of the only two reserves in Ghana with upland evergreen forest (Hall and Swaine, 1981; Abu-Juam *et al.*, 2003).

As a result of its uniqueness, the reserve has changed status over the years as a Special Biological Protection Area in 1994, a Hill Sanctuary in 1995 and as one of Ghana's 30 Globally Significant Biodiversity Areas (GSBAs) in 1999. In 2001, Atewa was listed as an Important Bird Area (IBA) by BirdLife International (Abu-Juam *et al.*, 2003; Rapid Assessment Program, 2007). McCullough *et al.* (2007) believed that water bodies originating from Atewa together with their assemblages of unique species owe their existence to the Atewa range formation, which soaks up rain and mist, and discharges clean fresh water into these streams.

Despite its importance in the provision of clean water for much of Ghana's human population and in the protection of key elements of the country's biodiversity, Atewa Range Forest Reserve has come under several threats in recent times.

One of the greatest threats is the discovery of bauxite in the mountain range after the Government of Ghana granted exploration license to Alcoa, an aluminum company to prospect for the mineral (Rapid Assessment Program, 2007). Gold was also discovered in the mountain range and the temptation for a poor country like Ghana, which was recently ranked 79 out of 145 countries in terms of population below poverty line (World Factbook, 2009), to exploit these minerals is very high. So far, the Government of Ghana has not taken any



firm decision concerning the fate of the bauxite after an initial attempt to lease the area to mining companies was resisted by pressure groups. The changing political regimes since the 1992 constitution came into force has also hindered the realization of this environmentally inimical act.

Another major challenge to the reserve is local dependence for livelihood enhancement. Local community members have since its establishment, derived food and fibre from the Atewa Range Forest Reserve, making it a key livelihood support entity for its fringing communities. The local population depends on the forest for logging, and extraction of fuel wood, cultivation of crops and for bushmeat (McCullough *et al.*, 2007, Rapid Assessment Program 2007). Considering its forest condition, Hawthorne and Abu-Juam (1995) gave the Atewa range reserve a score of 3 (on a scale of 1-6), which according to them shows that the forest is slightly degraded.

Furthermore, open patches within the reserve as a result of human activities are being colonized by invasive species notably the Siam weed (*Chromolaena odorata*), (McCullough *et al.*, 2007).

In view of the negative repercussions these threats and disturbances have on the Atewa Range Forest Reserve, this study aims at assessing local dependence on the products from the forest reserve, with the view to enhancing our understanding of forces of disturbance and to highlight the magnitude of the problem in order to inform policy makers and planners on the urgent need to protect this strategic watershed.

The choice of Atewa was guided by the strategic importance of the mountain range

forest as a biodiversity hotspot with its unique alpine vegetation and endemic species. It is also an important watershed upon which some major streams depend for their water intake (McCullough *et al.*, 2007), in the face of myriads of illegal human activities that continuously alter the land use system within the reserve.

The objectives of the study were to:

- investigate the types of products collected from the Atewa range forest reserve;
- determine the money value of products collected from the reserve;
- find out the underlying factors responsible for the local dependence on the reserve; and
- make recommendations that will help save the forest reserve from further disturbance.

Primary data for the study was derived from field survey carried out in 2007. During the survey, seventy six (76) questionnaires were administered in seven (7) communities. The communities included Bomaa, Asikuma, Asiakwa, Anwenease, Apaapam, Sagyemaase, and Labikrom all in the East Akim District of the Eastern Region. About eleven (11) respondents were randomly selected from each of the communities to answer a combination of pre-coded and open ended questions on variety of issues including use of forest products from the Atewa Range Forest Reserve.

Secondary data for the study was derived from available literature on watershed disturbance, and loss of forest cover and its effects on watersheds.

Data analysis employed two matrix statistical tables, percentages, and statistical charts. Qualitative techniques involving mainly descriptions and explanation of issues using graphical means in some cases, was employed

**Findings and Discussions**

*Background of respondents*

Out of the total of seventy six (76) respondents interviewed within the Atewa Rang Forest Reserve area, 68% were males while 32% were females. The majority of the respondents were in the age range 31–44 followed by age range 45–54. Fig. 2 shows a graphical representation of the percentage number of respondents by age range and sex. The respondents were predominantly farmers with most of them engaged in

subsistence production. The analysis further shows that 73% of the respondents have farming as their primary occupation while only about 14% engaged in trading, processing and other services. Eight percent (8%) of the respondents were teachers whereas 5% were unemployed.

*Local dependence on forest products from Atewa watershed*

The results of the analysis showed that there are widespread human activities going on in the Atewa Range Forest Reserve despite its ecological and biological importance. The reserve serves as a source of livelihood for most local people within the fringe communities, most of whom visit the reserve on daily basis. As shown in Fig. 3, a wide array of products including timber

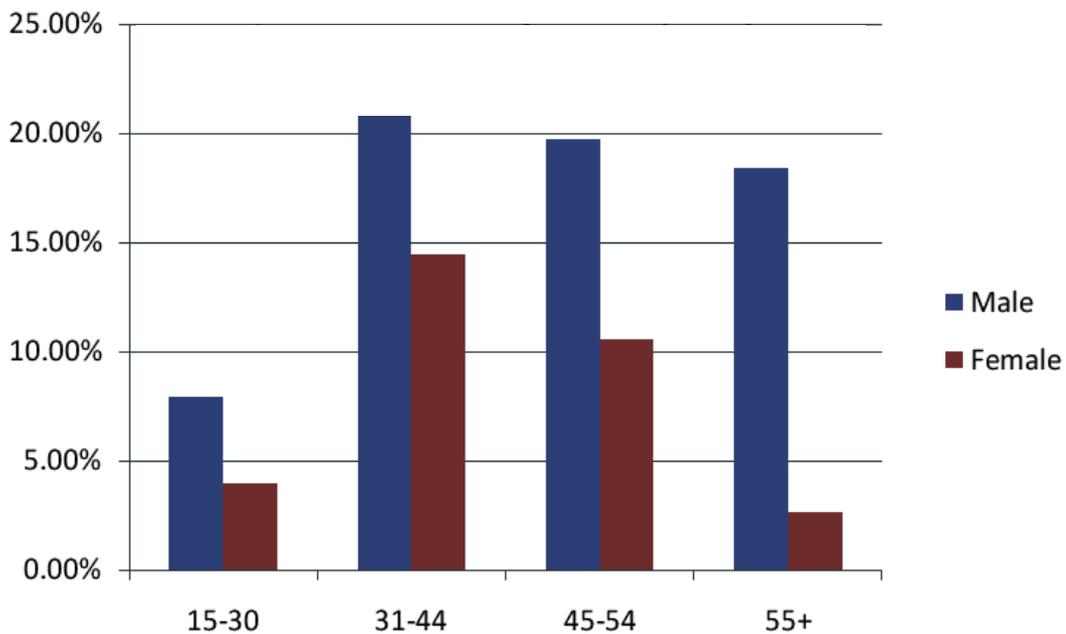


Fig. 2. Age range of respondents by sex

products, non-timber products, animal products and plant food products is derived from the forest.

Major activities degrading the forest include wood extraction for timber, firewood, pestles and mortars. Fig. 3 illustrates the number of people that depend on forest products for various reasons. The figure shows that a great number of respondents depend on the Atewa Range Forest Reserve for their domestic water supplies and also extract wood used as chewing stick (for brushing the teeth). A large proportion of the respondents also collect snails, hunt for bush meat and fell trees for use as constructional timber, and mortars and pestles for pounding and crushing food items. As shown in the table, minor activities, namely collecting of materials for cane, twine and sponge also exist.

The field data also shows that a significant quantity of forest products worth various amounts of money are collected from the forest reserve for consumption. The money value of each forest product consumed by each respondent per annum valued between GH¢109 and GH¢6357.2. Table 1 shows a list of 13 forest products, their respective money values per year, percentage of the value of each product against the total value of products consumed, and the percentage of consumers who consume each of the products.

*Money value of items collected from Atewa Range Forest Reserve*

An aggregation of money value of all forest products consumed by the sampled population as shown in Table 1, indicated that products worth about GH¢16,626.38

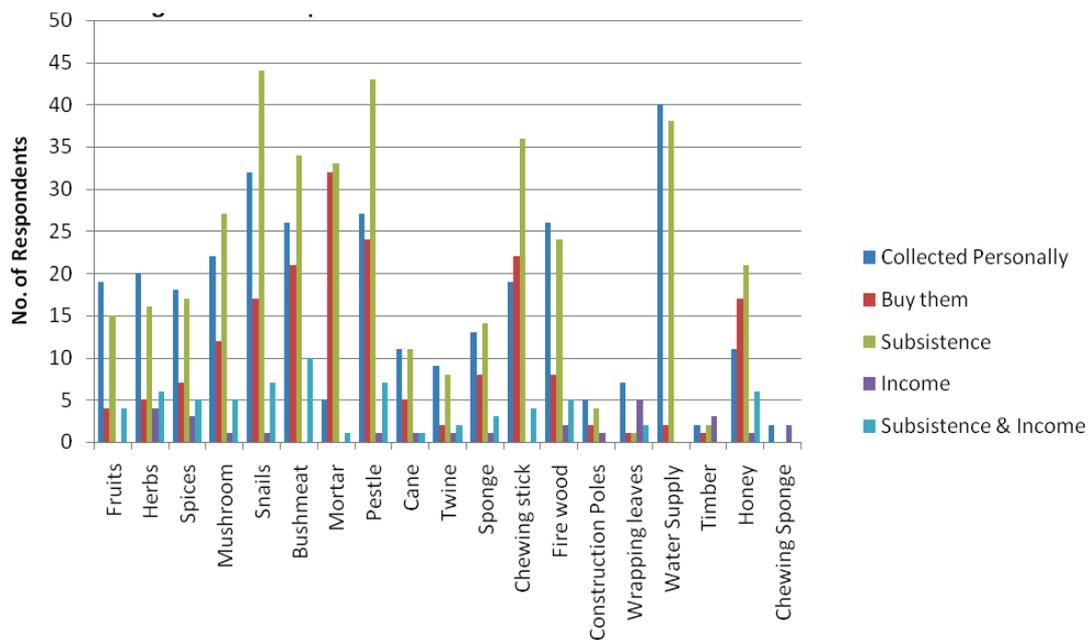


Fig. 3. Local Dependence on forest products and services from Atewa Range FR

TABLE 1  
*Money value of major forest products consumed annually by respondents from the Atewa forest block.*

<i>Forest Products</i>	<i>Total Value Consumed (GH¢)</i>	<i>Value (US\$)</i>	<i>Percentage of Total Value</i>	<i>Percentage No. of FP Consumers</i>
Bush meat	5400.2	5567.22	32%	53%
Cane	430.85	444.17	3%	9%
Chewing stick	128.78	132.76	1%	30%
Firewood	1235.2	1273.40	7%	32%
Fruits	620.8	640	4%	17%
Herbs	368.7	380.10	2%	12%
Honey	266.6	274.84	2%	26%
Mortar	109.25	112.63	1%	42%
Mushroom	667.3	687.94	4%	37%
Pestle	154.6	159.38	1%	63%
Snails	6357.2	6553.81	38%	57%
Spices	487.9	502.99	3%	18%
Twines	399	411.34	2%	4%
Total	16,626.38	17140.58	100%	

Source: Field Survey 2007

(US\$17,140.58) are consumed on annual basis by the sampled population. About 53% of the total number of respondents consumed bushmeat from the forest which was worth 32% of the total value of forest products consumed during the period. Also 63% of the respondents extract wood for pestles which was just 1% of the total money value of items consumed. Quantity of snails consumed per year, yielded the highest percentage money value representing 38% of the total value, and this was consumed by 57% of the respondents.

Field data again shows that apart from daily consumption of forest products, a small number of respondents also sell some of these products for money. Table 2 shows that only between 1% and 12% of the sampled population sell either one or more of the forest products listed, compared to between 4% and 63% who consume the products. One pertinent observation was

that the total amount earned on quantity of products sold (GH ¢15,793.8 or US\$16,282.3) is slightly less than the money value of quantity consumed (i.e. GH ¢16,626.38). However, a critical observation of the figures revealed that there was one chainsaw operator among the respondents whose income from the sale of timber alone accounted for almost 46% of the total amount earned on quantity sold by all respondents.

These observations indicate that there is widespread encroachment by the fringe communities in the Atewa Range Forest Reserve to extract all kinds of forest products. Major non-timber products collected from the reserve include mushrooms, twines and honey. Bushmeat and snails from the reserve also form an important part of the dietary needs of the local people. Though the collection of these products may not necessarily change the

TABLE 2  
Income derived from quantity of forest products sold in 2007

<i>Forest Product</i>	<i>Total Income in GH¢</i>	<i>Total Income in US\$</i>	<i>% of Total Value</i>	<i>No. of FP Sellers</i>	<i>Percentage No. of FP Sellers</i>
Bush meat	1343	1384.54	8	6	8
Cane	572	589.69	4	2	3
Chewing stick	106.4	109.69	1	6	8
Firewood	942.8	971.96	6	6	8
Fruits	694.3	715.77	4	4	5
Herbs	337	347.42	2	3	4
Honey	412.6	425.36	3	9	12
Mushroom	379.6	391.34	2	3	4
Pestle	569.8	587.42	4	9	12
Snails	1606	1655.67	10	6	8
Spices	765	788.66	5	5	7
Sponge	118.5	122.16	1	3	4
Timber	7,300	7,525.8	46	1	1
Wrapping leaves	646.8	666.80	4	8	10
<b>Total</b>	<b>15,793.8</b>	<b>16,282.3</b>	<b>100%</b>		

Source: Field Survey, 2007

forest cover of the reserve, the activities still constitute land use change, according to Ellis and Pontius, (2007), since the reserve was not designed for these activities.

A major threat to the reserve emanate from the activities of a few illegal chainsaw operators in the area (Sarfo-Mensah 2005). The analysis of field data confirmed this assertion and showed that out of all the forest products consumed or sold, extraction and sale of timber from the reserve yielded the most income. The danger is that if this activity is not halted, it could get out of hand and eventually degrade one of Ghana's finest reserves and watershed beyond recovery.

#### *Some underlying factors of illegal encroachment*

Several underlying factors are responsible

for community encroachment in the Atewa Rang Forest Reserve according to responses received from field work. The first is lack of income generating activities and effective livelihood enhancement opportunities. Out of the total number of respondents interviewed, 72.36% were farmers, 3.95% were traders, 9.21% were into other services like dress making and hair dressing, 7.89% were public servants and 5.26% claimed they were unemployed. The respondents claimed that these activities did not yield enough income to meet their day-to-day needs, hence their decision to collect forest products for sale.

Population increase within the fringe communities especially the major towns adjacent to the reserve is also a factor. Kibi, a major town at the foothills of the range, for instance, has seen population increase from

5,069 in 1960 to 9,612 in 2000 (i.e. almost doubled) whereas Kwaben at the north eastern part of the range increased from 4,138 to 5,836 within the same period (Republic of Ghana Population Census, 1989, Ghana Statistical Services, 2005). Nation-wide the rate of population growth is 2.4 (GSS, 2010) and this has a direct bearing on all state resources including the Atewa Range Forest Reserve since population is mobile.

Another major underlying factor is the fact that people from a wide range of locations patronize products collected from the reserve by local residents. The respondents listed at least 18 different locations ranging in distance between 5 km to about 120 km from the study area, as the destinations of people who patronize the forest products. Some of the locations are Accra, Adukrom, Ahuniase and Asiakwa. The items mostly patronized are listed in Table 3.

Some of the respondents admitted that most of the products are sold by hawkers by the road side and that in majority of cases, they do not know the destination of the buyers. This shows that the demand for forest products is actually generated from

remote locations outside the study area and it will take a great deal of effort to reverse the trend.

On the whole, timber extraction, illegal hunting and felling of wood for fuel wood, pestles and mortars, are real challenges to the watershed, which if not checked, have the potential of degrading the forest reserve. According to the District Forestry Officer at Begoro, the management of the reserve has unfortunately been saddled with inadequate staff capacity and lack of logistics to ensure effective monitoring. Occasionally, such encroachers are arraigned before the courts but the fines were reportedly not deterrent enough.

#### *Impacts of Atewa range watershed disturbance on ecosystems*

The impacts of disturbances on water resources on one hand, and inadequacies in management capacity of Ghana Forestry Commission to enforce regulation in the Atewa Range Forest Reserve on the other, pose several threats and challenges to the watershed. Box 1 provides a summary of the threats and challenges facing the reserve as enumerated by Rapid Assessment Program (2007).

TABLE 3  
*List of products patronized by people from outside the communities surveyed*

<i>Timber Products</i>	<i>Non Tree Products</i>	<i>Animal Products</i>	<i>Food products</i>
Timber for construction	Sponge	Bush meat	Fruits
Pestle	Twine	Snails	Plantain
Mortar	Cane	Crabs	
Poles	Thatch		Wild yam
Chewing stick	Herbs		Cassava
Firewood	Wrapping leaves		Spices
	Mushroom		
	Honey		
	Water supply		

## Box 1

*Threat and challenges to the Atewa range forest reserve*

- Intensive agriculture has led to leaching and loss of soil fertility in parts of Atewa.
- In some villages, deep channels have been created by surface water running over ground lacking plant cover.
- Illegal logging has been a major issue in Atewa, especially during the 1990s, leading to further problems with erosion throughout the area.
- Unsustainable exploitation of forested areas, coupled with the relatively high frequency of bush fires, has resulted in the depletion of important timber species. Trees such as Mahogany, Odum, Obeche, and Emire, which were abundant before the 1960s, are now locally rare.
- Mining activities by unlicensed individuals and groups are increasing and causing serious problems for communities. Major pollution, as a result of improper mining practices, occurs downstream from water bodies along whose banks mining takes place.
- Animal populations, especially those of larger mammals, suffer seriously from illegal hunting. About 15% of the bushmeat found in the markets in Accra and Kumasi comes from the Atewa forest. Most of the species sold are wholly protected in Ghana (including the Black-and-white colobus, Spotted palm civet, Giant and Long-tailed pangolins). In addition, some traditional sacred animals (totems) such as Crested porcupine are being hunted and sold.
- Hunters illegally entering Atewa are known to use automatic rifles, poisonous chemicals, traps and fires.

Source: Rapid Assessment Programme (2007)

The impact of illegal human activities on the Atewa Range Forest Reserve cannot be gain said. Habitat destruction and the loss of biodiversity have the tendency of reducing forest resilience against external drivers like climate change. Studies have shown that biodiversity is very vital in forests' ability to withstand external pressures, and the capacity to recover to their pre-disturbance state or adapt to changing conditions (Gunderson, 2000). Therefore, considering the high rate of bush meat consumption and timber extraction, Atewa, which constitutes a strategic forest patch within a heavily degraded landscape stands the risk of losing its resilience and could become vulnerable to climate change. If these activities are not checked, the water bodies which owe their existence to the watershed will be negatively affected.

### Conclusion

The study examined the Atewa Range Forest Reserve as strategic biodiversity hotspot with its unique vegetation and endemic species, and as an important watershed upon which some major rivers namely Densu, Birim and Ayensu depend for their water intake. The results revealed that not only do local people exploit forest products like timber, fuel wood and bushmeat for home consumption but they also trade in these products. Income derived for the sale of forest product in the seven (7) communities within a year was estimated at US\$ 84,014.22 (GH¢81,493.80), which is very significant. One major underlying cause of the high local dependence on the reserve is demand pressure not only from the neighbouring communities but the travelling public who patronize the forest products from hawkers by the roadside.

In conclusion we wish to reiterate that watersheds are very vital in the supply of water for both urban and rural users. It enhances sub-surface flow as a result of high infiltration capacity and reduces erosion due to protective vegetation cover. Watershed protection against every form of disturbance is thus very crucial if we want to ensure a good quantity and quality of water supply to streams. It is therefore a collective responsibility on the part of government, local communities and the citizenry to place environmental issues first before any parochial interests.

### Recommendations

The following income generating activities were suggested by the local people:

1. support for off-farm activities namely snail farming, domestication of selected wildlife species like grass-cutter (cane rats), and nursery establishment involving valuable timber species;
2. financial support in terms of micro-credit to support commercial activities like retail of farm produce, bulk transportation and distribution of food stuffs to the urban markets, as well as establishment of grocery shops and stalls within the respective communities;
3. skill training specifically in dress making, artisanal industry, auto-mechanics and hair-dressing; and,
4. finally provision of agricultural inputs like improved seeds and tractor services, agro-chemicals to intensify agriculture and improve yields.

In addition to these income generating activities for local livelihood enhancement, the National Forestry Commission also needs support in terms of capacity building to be able to meet its forest management

objectives. The Commission should also consider designating the Atewa Range Forest Reserve as a National Park to give it a full protection status and improve its management effectiveness.

Finally, there is a need for the Forestry Commission to strictly enforce its buffer zone policy in order to protect the mountain slopes outside the reserve and the foothills.

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