The impact of human activities on floodplain in Amani, East Usambara Mountains, Tanzania.

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Abstract

This study was carried out to investigate the impact of human activities on a floodplain in Amani, East Usambara Mountains, Tanzania. Fishing for crabs and foraging activities were the two major human activities studied along the floodplain over four days. Locally made traps (mgono) and pond nets were used to catch crabs along the floodplain stream. Number and size (length and width) of crabs both in traps and caught by pond nets were recorded. A non-parametric Mann Whitney U test was carried out to distinguish between the medians and these were found to be significantly different at $P<0.0001$.Traps selected or larger crabs. The population of crabs in the stream was estimated by using a mark-release-recapture method. Questionnaires were also used in this investigation. The total number of bundles of cattle forage cut per year was estimated from the questionnaires. The weights of five bundles cut by men from the floodplain were estimated and compared with weights of five bundles we cut. The area cut on the floodplain was determined by relating the surveyed area on a sketch map to its equivalent on a surveyed map of part of the area. Productivity, biomass and turnover rate of the floodplain grassland were estimated. The turnover rate was found to be very large, partly due to some sampling errors. No statistical analysis was possible as only one estimate of number of bundles cut was available, but the turnover rate appears to be naturally high.

Introduction

The value that people gain from the natural environment can be divided into four categories (Martin, 1995). Direct economic value is derived from the food, construction materials, medicinal plants and other goods harvested from natural areas as well as from

recreational facilities and other services. Indirect economic value refers to benefits provided by various other environmental services including regulating climate, purifying water, maintaining the fertility of soil and absorbing waste products.

Aesthetic value based on appreciation of the beauty of nature is manifested when people engage in ecological tourism including bird watching, nature photography and hiking. It may also be derived from the more abstract pleasure of knowing that natural areas, plants and wild animals are available even if a person never travels to see them. Ethical value comes from the belief, common to many cultures that life has intrinsic significance-its value is derived simply from the fact that it exists.

However, humans have great impacts on the above values. In undeveloped parts of a region, environmental damage generally results from the over exploitation of living resources. It has been estimated that more than 70% of riparian forest may have already been removed from the Namibian section of the floodplain of the Okavango river (Day, 1997). Forest on the East Usambaras have been exploited by man for at least 2000 years but have recently come under severe pressure, the result of greater industrial activity and an increasing human population (Hamilton 1982).

Near Amani Tanzania is a small floodplain where the river Dodwe, a tributary of the Sigi River is found. The Sigi supplies water to the surrounding community and coastal town of Tanga (Litterick, 1989). A floodplain is a flat river valley, full of deposited sediments where the river meanders in its dry season channel but expands to fill a wider channel in the wet season. Flood plains are believed to be highly productive because of their fertile soil, which supports agriculture and abundance of water. There are also potential human impacts on them, including deforestation of the surrounding land, overfishing, pollution of land and water, and soil. Our project was to assess whether the use of the Amani floodplain is sustainable or not.

This floodplain is used for fishing mostly freshwater crabs and small fish, consumed locally as a source of protein. Fishing activities are mainly done when it rains using locally made traps commonly known as “mgono” and by diverting water to reduce the volume in the stream so the crabs and/or fish can be picked out by hand.

Agriculture is another activity that uses the floodplain, both for crop production and harvesting of plant material as fodder for animals housed in shaded buildings. Crops include cabbages and yams for both home consumption and commercial purposes.

The specific objectives of this study on this small floodplain were;

- to assess the risk of overfishing of crabs. We hypothesized that the fishing might be selective of the large and potentially more important reproductive of crabs.
- to assess the degree of cutting of forage and estimate the turnover rate of the vegetation as a result of cutting and compare it with other sites. We hypothesized that the turnover rate would be comparatively high compared to other grasslands in drier areas.

Study site

The study was conducted in the Amani Nature Reserve in the East Usambaras Mountains, Tanzania, in September 2003. The East Usambaras are part of the Eastern Arc mountains and they cover an area of 1300km² between 4˚ 48', 5˚13'S and 38˚32', 38º48'E (Hamilton 1982). These mountains are close to the coast in the north-eastern corner of Tanzania with an altitude range of 900-1000 metres above sea level.

The river Dodwe (5º6'S, 38º38'S, 910masl) is a tributary of the Sigi River. It is a result of damming about hundred years ago. The dammed stream then created a section of standing water, which has filled with detritus and now bears a meandering stream in a floodplain 15-50m wide and approximately 2 km long, usually flooded in wet season.

Methods

Study of the impact of human activities was based on two activities in the River Dodwe floodplain namely fishing for crabs and cutting of forage for cattle.

Fishing for freshwater crabs

Comprehensive efforts were made to identify human impacts on the crab population of the floodplain. Three methods were used: questionnaires (Appendix 1), measurement of

the size and number of crabs caught in traps and by pond nets and estimation of the total population of crabs using the mark-release-recapture method.

A locally made trap (mgono), baited with pieces of raw cassava and jack fruit, was placed in the stream, with its opening facing the flow of water. The mgono is made in such a way that when a crab enters it can't escape. The trap was set and emptied daily for four days. The number and size(length and width) of the carapace of the caught crabs were measured. We also caught crabs using a pond net, and measured and recorded the number and size of all crabs so as to compare them with those in the traps. Comparison of frequency distribution of size by the Mann Whitney U test was carried out.

The population of crabs in the stream was estimated using the Lincoln Peterson Method. A sample of the population was captured in debris dams of known size using a pond net. Each individual crab was marked by a spot of paint on its upper carapace. Then the marked crabs were released to mix with the remainder of the population. The number of crabs caught and marked was recorded. The recapture was done in the following day when the total number of crabs recaptured and the number of marked crabs was recorded. Finally, the total population number in the studied stretch was estimated by using the following formula;

$$S1/N=R/S2$$

Where S1= Number of individuals caught and marked in the first sample; N= Total number of population; R= Number found marked in the second sample; S2= Total population caught in the second sample

Foraging activity

We used questionnaires to determine the total number of bundles of forage cut per day, which was later used to calculate productivity. The weights of each bundle cut by men from the floodplain were estimated by weighing a handful of grass using a Pesola balance and multiplying that weight by total number of handfuls in one bundle. A total of five bundles were estimated. The area cut for each bundle was also estimated. We

also cut and measured the weight of grass in given areas (1m²) on the floodplain. Five areas of 1m² were cut.

A map of the entire floodplain, showing the area of cut grass was carefully sketch-mapped by a colleague (Miss Kerry Waylen). Part of this total area had been surveyed by tape and compass. By relating the surveyed area to its equivalent on the sketch map we were able to scale the sketch map and determine (using tracing and graph papers) the area of cutting.

Finally, we calculated the turnover rate of the floodplain grassland vegetation using the following formula;

Productivity (weight area^{-1} year^{-1}) = **Biomass** (weight area^{-1}) * **Turnover** (year^{-1})

The biomass was the fresh weight obtained by dividing the weight harvested by the area cut. The fresh biomass was then converted into dry biomass, multiplying by 0.9(90%).

The productivity was obtained by dividing the product of the mean weight of the bundles and the total number of bundles cut per year by the total area of the floodplain cut.

No statistical analysis was possible, as only one estimate of number of bundles cut was available.

Results

Fishing for freshwater crabs:

Results obtained from the questionnaires showed that out of 10 respondents only 3 fish for crabs on the floodplain though the sample might be biased towards those living close to the floodplain and more likely to fish for crabs. This represents 30% out of the total population of 760 people of Mbomole village, which surrounds the floodplain. An average of 10 crabs are claimed to be caught per day. The community prefers medium and large crabs, releasing back the small ones into water.

Distribution pattern of number and size of crabs

Figure 1 shows number of crabs trapped each day for a period of four days. It averaged 6.75, which is close to that estimated by the questionnaire survey (10) though a little lower.

Figure 2 shows the frequency distribution of crab size (length and width) of trapped crabs. A normal curve has been fitted but the distribution is skewed towards the left (small sizes).

Figure 3 shows the distribution of crabs caught by a pond net over several days. Again a normal curve has been fitted but the data are clearly skewed towards the left.

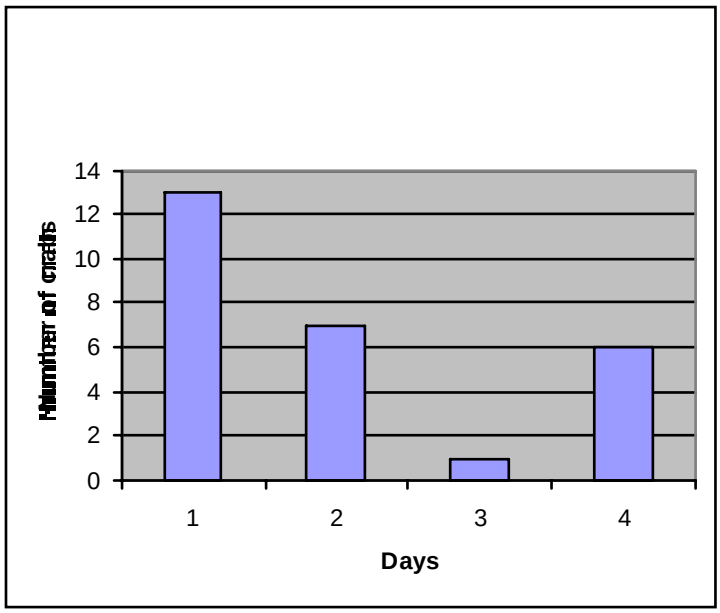


Figure 1. Number of crabs caught in floodplain stream in Amani, Tanzania in four days, September 2003.

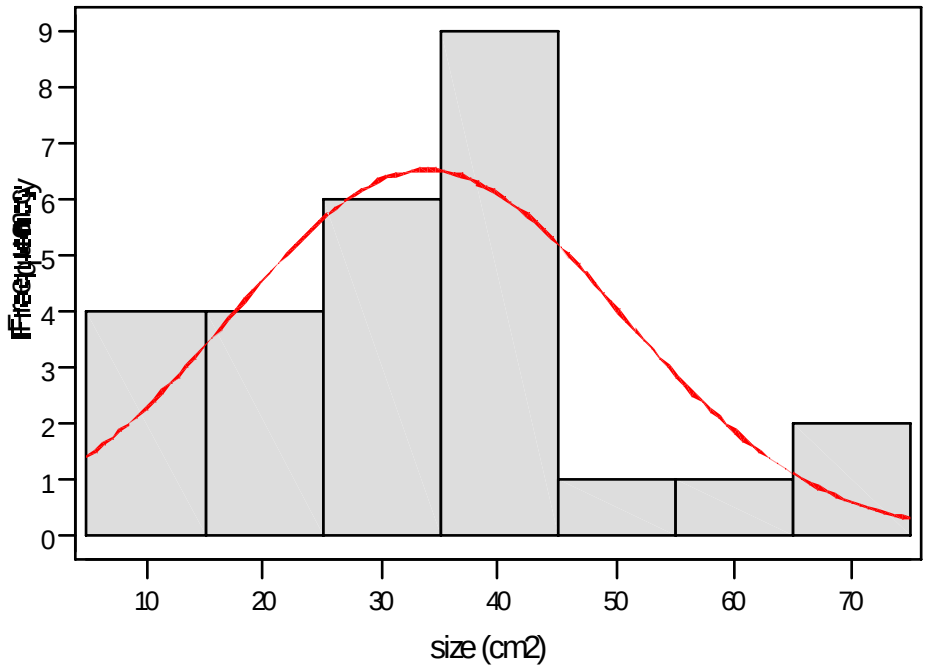


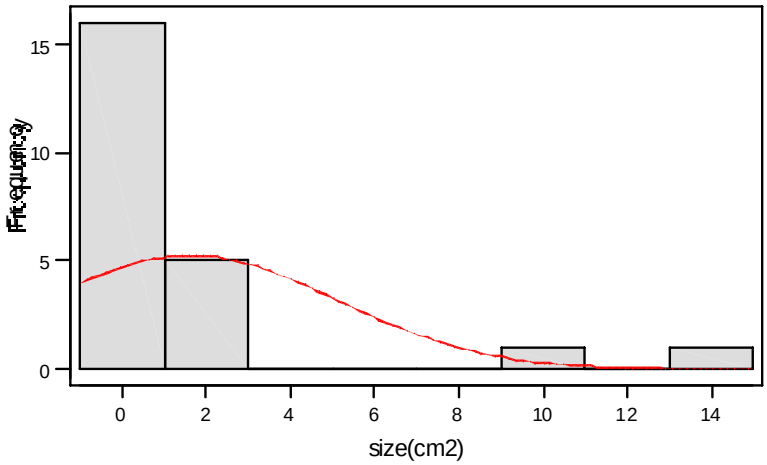
Figure 2. Frequency distribution of the size of crabs caught in traps in a small floodplain stream in Amani, Tanzania, September 2003.

Table 1 shows the mean, median and standard deviation of the length, width and size of crabs in the trap and those caught by a pond net.

Statistical analysis of crabs in traps compared with sampled crabs

The data do not form a clear normal distribution and so a non-parametric Mann Whitney U test was carried out to distinguish between the medians and these were found to be significant at P<0.00001.

Figure 3. Frequency distribution of the size of crabs caught using a pond net in a small



floodplain stream in Amani, Tanzania, September 2003.

Table 1. Descriptive statistics of crabs caught in the Amani floodplain

	Mean	Media	Standard

		n			Deviation				
	No.	Length (cm)	Width (cm)	Size (cm^2)	Length (cm)	Width (cm)	Size (cm^2)	Length (cm)	Width (cm)	Size (cm^2)
Crabs in trap	27	6	5	34	6.4	5	33	2	1	16
Crabs in pond net	23	1	1	2	1	0.4	0.3	1	1	4

Estimated crab population

The total number of crabs captured and marked in the first sample was 15. In the second sample, 21 crabs were caught out of which only 4 crabs were marked.
Therefore, the total number of the population according to Lincoln's formula was found to be 79(per 30m²), that is 3crabs/m². No marked crabs were found after two days 20m away from the area of the capture, suggesting that dispersion is low.

Foraging activity

From the questionnaires, the total number of bundles cut per year was found to be 14600. The average estimated weight of bundles cut by farmers per day was found to be 51kg, from an average area of 60m² whereas that we cut (1m²) was found to be 0.4kg. The estimated biomass (weight/area) of the farmer's bundle was $0.8kgm^{-2}$ whereas that of our bundle was $0.4kgm^{-2.}$ However, we may have harvested an area that had recently been cut so our value may be low. The dry biomass per bundle was $0.72kgm^{-2.}$

The area of the floodplain cut over the year was estimated to be $7041m^2$. The estimated productivity was therefore found to be 105 kgm^{-2} yr^{-1}. Finally, the estimated turnover rate was found to be $132yr^{-1.}$

Table 2 shows data on Biomass of forage cut by farmers and experimentally from a floodplain.

Table 2. Biomass of forage cut by farmers and experimentally from a floodplain, near Amani, Tanzania. Experimental harvest: 0.4 +/- 0.09 (kg m^{-2})

Bundle	Area (m^2)	Weight (Kg)	Fresh Biomass

			(weight/area)
1	40.2	50	1.2
2	52	34	0.6
3	84	92.4	1.2
4	44	35.15	0.8
5	66	43.75	0.6

Discussion

Fishing for freshwater crabs:

Most freshwater crabs have direct development rather than hatch as small fragile larvae. They brood large yolky eggs that hatch at a later stage, and the eggs may be very resistant to desiccation, hatching when supplied with water. (Moore, 2001).

The results show that the traps take big crabs. This implies that, compared with the non-trap samples, the number of big crabs which carry the eggs will be reduced in the long run which in turn will affect the population of crabs in the stream. Bigger crabs protect their eggs which are few and it was discovered that only bigger crabs are taken. This implies that the population may decrease with time since there will be no crabs to protect the few eggs.

The results also show that the crabs tend to concentrate in one place, that is they are not migrating. Fishing of crabs was observed to be conducted in places with concentrated crabs and this may reduce the population through over fishing in these areas but may also limit the fishery so that the population may be able to recover.

Foraging activity

The following table shows the turnover rates of different ecosystems.

Table 3. The turnover rates of different ecosystems of the world (Begon et al, 1990)

Ecosystem type	**Productivity (weight area^{-1} year^{-1})**	**Biomass (weight area^{-1})**	**Turnover rates (yr-1)**
Tropical rainforest	37.4	45	0.8

Tropical seasonal forest	12	35	0.3
Temperate grasslands	5.4	1.6	3.4
Swamp and Marsh	4	15	0.3
Woodland and shrubland savanna	6	6	1

As compared with the turnover rates of different ecosystems in the world, our turnover rate ($132yr^{-1}$) is very high. This might be due to some errors in our data such as overestimation of bundles cut per day and underestimation of the area cut on the floodplain, all of which would tend to give overestimate of turnover. Floodplains however are very productive probably due to plenty of water, nutrients from the soil and plenty of light and it is likely that they do have high turnover rate.

This study concludes that there is an impact of human activities on the floodplain as seen in the discussion of crab fishing and foraging. A study is required in future in other areas during all seasons.

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Appendix 1. QUESTIONNAIRE

Name……
Age class

10-20	0…..
20-30	6…..
30-40	3…..
40-80	1……
Sex	3F 7M
Village name	MBOMOLE

A: FISHING

1. Do you catch crabs along the stream?
   Yes 3(2M 1F)…
   No 7…
2. What for?
   Home consumption 3……
   Selling 1…….
3. How many crabs do you catch per day?……
   2, up to 10, 11……..
4. Do you eat the whole crab?
   Yes 0……..
   No 2……

5(a). If No, what do you eat?
   Not shells, intestines

5(b). Where do you put the shell thrown away?
   2, just throw away

6. Which areas along the stream do you prefer to catch crabs?
   Near my house to take care of my trap, areas where water is covered by vegetation; all areas

7. What size do you prefer?
   Small 1…
   Medium 2…
   Large 2….
8. Where do you put the unwanted crabs?
   Release them back

B: FORAGING:

1. Do you have some animals?
   Yes 10
   No 0

1b. If Yes, How many? ……5, 3, 12, 4, 6, 3, 3, 5, 4, 8

2. Where do you get fodder for your animals?
   a. Zero grazing 10
   b. Grazing 0
3. Which type of plants do you prefer?
   a. sedge 9
   b. grass 10..
   c. herbs 10
   Why? Available near my own place; many cows
4. Where do you cut the grass?
   At the floodplain, Monga, at Shamba
5. How often do you visit the place for cutting the grass?
   Everyday, 9
6. How many loads each day?……
   4, 4, 4, 3, 4, 2, 3, 3, 4, 9
7. Which spp do you prefer and why?……
   All; herbs, tikini(found near stream)