



**Research Paper**

**Participatory GIS in Mapping Local Context of Conflicts over Pastoral Resources: Case of Duru Haitemba Community Forest in Babati district, Tanzania**

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**Abstract:** *Conflicts over pastoral resources are not new among pastoralist communities. This paper presents findings of a research on Participatory GIS (PGIS) in mapping local context of conflicts over pastoral resources which was carried out in Duru-Haitemba community forest, Manyara region in Tanzania. Community mapping and PGIS were used interchangeably in the research. The research specifically intended to i) identify existing grazing resources use, access and conflicts among pastoralists and other land users, ii) study how PGIS can be used to identify grazing resources, pastoralist's uses and access interaction iii) examine the effectiveness of PGIS approach as tool for assessing spatial temporal distribution of conflicts. PGIS combined with interviews, geo-coded transect walk, observation and focus group discussion were used to understand actual situation in the field. Community mapping and PGIS outputs were used to ground truth conflict areas after mapping. The outputs combined with different processes in Arc GIS and ERDAS facilitated visualization of conflicts and its distribution. 79 heads of households, 7 village leaders and professionals were identified through systematic random sampling for interview. The research found out that there were conflicts over pastoral resources among agro-pastoralists and other actors at village, district and indirectly at national levels. Conflicts are spatially distributed in the forest areas, around water sources and along water bodies due to incompatible interests in those areas among different actors. Decisions to convert grazing land to other uses were made with less or no participation of the concerned actors. Population increase, more demand of farmlands and conservation has reduced quantity of grazing resources. Inadequate coherency and linkage in policies and directives demonstrated negative impact on prior made decisions. PGIS through community sketch mapping proved to be useful tools for examining conflicts and their spatial-temporal distribution, which could not be done through conventional GIS and remote sensing by interpreting and classifying images. Therefore PGIS in context of this study is considered as Participatory Digital Mapping that empowered participants and community through knowledge sharing and raising awareness during and after the mapping exercise.*

**Keywords:** Pastoral resources conflicts, Participatory Geographic Information System, Duru-Haitemba.

**Introduction**

Livestock production is one of the major agricultural activities in Tanzania. The sub sector contributes to national food supply, converts rangelands resources into products suitable for human consumption such as milk, meat, skin and hides <sup>[29]</sup>. Apart from that it is a source of cash incomes and inflation-free store of value. It provides about 30% of the Agricultural GDP. Out of the sub sector's contribution to GDP, about 40% originates

from beef production, 30% from milk production and another 30% from poultry and small stock production <sup>[34]</sup>.

Livestock production originates from a large resource base composed of the different livestock species, breeds and types whose ownership and distribution differ from region to region. In Tanzania context three livestock production systems are commonly distinguished in the rangeland areas, commercial ranching, pastoralism and

agro-pastoralism<sup>[34]</sup>. Sibuga *et al.*, (2004)<sup>[29]</sup> highlight that livestock production system enable people to live in semi-arid parts of Tanzania. In these areas livestock production contributes to the sustainable livelihoods and security of the rural poor in many ways<sup>[13]</sup>. In rural areas livestock plays a central role in the non-monetary economy and in the social life, as well as providing draught power for cultivation and transports<sup>[23]</sup>.

Duru-Haitemba forests are under community ownership and management since 1996<sup>[40,41]</sup>. The area has been cited much as one of the most successful Community Based Forest Management (CBFM) practices in Tanzania and other countries<sup>[10,15,40,41,42,43]</sup>. After intensification of CBFM activities, the community formulated by-laws on resources uses and access, as a result the community is restricted to graze inside the reserved forests. However, Duru-Haitemba villagers are agro-pastoralists and livestock keeping ranks second source of livelihood. Access and uses of forest as grazing area has been ranging from limited to completely prohibited as by-laws changed over time<sup>[10,17,41]</sup>. In one way or another, development has affected other forests resources' dependent as expressed by Wily (2001)<sup>[42]</sup> that "there were local losers in this development, larger cattle-keepers who were restricted to seasonal grazing rights". Studied villages information indicated that grazing in the forest is completely banned<sup>[4,6,27]</sup>. Alternatively, grazing was done along areas with water bodies' but recent conservation directives disallow that practice in the earlier mentioned areas. In addition there is no communal grazing land in the study area.

Livestock grazing in the forest is one of the factors that destroy the forest<sup>[38]</sup>. In the communities situated in arid and semi-arid areas especially pastoralists and agro-pastoralists forests are highly useful source of fodders. According to (URT:DHS, 1997)<sup>[36]</sup> Arusha (by then Manyara included) falls under central semi-arid zone of Tanzania, where most inhabitants practised an agro-pastoral livelihood strategy<sup>[26,35]</sup>.

Conservation of forests may sometimes differ with livestock keepers' interest as they rely on forests as grazing areas. IUCN-EARO and Mariki (2002)<sup>[9]</sup> explain that while forests and grasslands are taken for granted as regards livestock development, effective preservation and conversion to other uses adversely affects livestock keepers.

Natural pressure such as prolonged recurrence of droughts and anthropogenic activities such as intensification of smallholder crop cultivation, game reserves and large-scale irrigation schemes too have interfered pastoralism<sup>[24]</sup>. These processes have tended to deny pastoralists right of access to land and forests, previously perceived by local pastoralists as traditional grazing areas. There are growing social conflicts, environmental concerns and land uses conflicts due to haphazard alienation of rangelands for large scale agriculture. The extensive alienation frequently disown pastoralists of

their grazing lands<sup>[33]</sup>.

In Tanzania conflicts between farmers and pastoralists have been registered in a number of areas including Morogoro, Chunya (Mbeya), Mpanda and Sumbawanga (Rukwa), Tabora and Arusha regions<sup>[9]</sup>. Pastoralists are sometimes regarded minorities as they lead a different way of life in terms of culture, values and language<sup>[24]</sup>.

Conflicts over natural resources are increasing in number and severity, there are growing conflicts between agriculture and other land uses. This problem has been compounded with the increasing population and scarcities of natural resource in the developing countries<sup>[30]</sup>. The latter is caused human and livestock populations increase, which brings about increasing demands of food and fodder which imply more land for production. The livestock numbers have been increasing steadily (Tanzania ranking third in Africa) in recent decades at roughly the same rate as the human population growth<sup>[34]</sup>. To meet the increased demand, land uses change over time as land sizes remain the same, for instance changing grazing lands into farm lands consequently reduced pastoral resources. Potential areas to pastoralists have been converted to what perceived more profitable "... there has been a conversion of formerly pastoral land into large-scale farms and a good example is Naberera farm in Simanjiro"<sup>[13]</sup>. Conversion of pastoral lands into other land uses without considering interests of the pastoralists conflicts with Agriculture and Livestock policy that advocates for community involvement in resource management, land use planning and conflict resolution<sup>[33]</sup>. In turn pastoralists are affected socially and economically because of problems in access and uses of available scarce resources in line with the rules, regulation and by-laws formulated to manage natural resources such as land and forest. Ultimately disputes may occur as a result of dwindling resources and resources use pressure. Decrease in grazing lands imply increase in poverty among pastoralists then as a production system and a way of life, pastoralists appear to be fighting a losing battle to gain back their lost source of subsistence, hence conflict outbreak among pastoralists and other land users especially large scale agriculturalists.

Geographic information systems (GIS) have been widely used to support land use planning processes by providing baseline data and producing output information for decision-making<sup>[11]</sup>. PGIS emerged and to a reasonable extent it has proved to be useful in conflict mitigation, land ownership studies as well as other natural resources access and management in several ways<sup>[20]</sup>. Since the villagers are agro-pastoralists this study addresses visualization of what is happening on the ground through PGIS approach.

## Material and Methods

**Study area:** The study was conducted at Duru-Haitemba community forest which is located in Manyara region, about

200kms South of Arusha in the northern part of Tanzania, and about 750km from Dar Es Salaam. The forests are within the boundaries of 8 villages, about 25km from Babati town. The location of the study area is shown in figure 1.

The study was carried out in Duru, Riroda and Hoshan villages as seen on figure 1 above. The forest is typical dry miombo woodlands. The dominant species are *Brachystegia microphylla* and *Brachystegia spiciformis* [17]. Duru-Haitemba dry miombo woodland forests cover about 9,045ha. Since 1996 the forest has been actively and legally managed by eight village communities. For management purposes, each of the eight villages has its forest portion. These portions appear in patches and fragmented.

Duru-Haitemba is a relatively dry area, characterised by bi-modal and irregular rains ranging from 300–1200mm per year. Sometimes rains of short duration occur during October to January while there are rains of long duration from February to May [10]. Occasionally the areas experience extended dry season for 6 months in a year [15]. According to (URT:DHS, 1997) [33] part of Arusha region (by then Manyara included as a district) falls under central semi-arid zone of Tanzania. The area lies between 950-2000 meters above sea level.

Inhabitants of the studied villages (Duru, Riroda and Hoshan) are mainly agro-pastoralists with very few farmers per se. Major and native ethnic groups living in the area

include, Fiome, Iraqwi, Barbaig, Gorowa and Mang`ati, who are traditionally pastoralists or agro-pastoralists. Agro-pastoralists keep livestock like cattle, oxen, goats, sheep, donkeys, pigs and chicken. Major crops cultivated consist of pigeon peas, sunflower and sorghum as cash crops and maize, beans as food crops. On average majority own land ranges from 1.5 to 8 acres, few 9-15 acres, and very few with more than 20 acres who in most cases are earliest inhabitants and considered rich in the areas. Anyone who owns more than two heads of cattle is considered a livestock keeper, on average livestock keeper owns 4-12 heads of cattle, 5-10 goats, 3-6 sheep, and at least 1 donkey. Those who are considered rich in the study area own at least 1 pair of oxen and 3 or more donkeys. Fishery is practised in sub-villages of Hoshan and Riroda, which are close to Lake Babati.

**Data types and collection:** Tools used for data collection in this study included literature review, participatory/community mapping, geo-coded transect walk, interview, field observation and focus group discussion.

**Community mapping:** Simultaneously with focus group discussion community mapping i.e. PGIS was done after household interviews in all three villages in order to identify grazing related conflicts and effectiveness of PGIS in examining those conflicts. Other studies suggest that community mapping and local knowledge can be used to enhance planning, decision making and NRM [20,25].

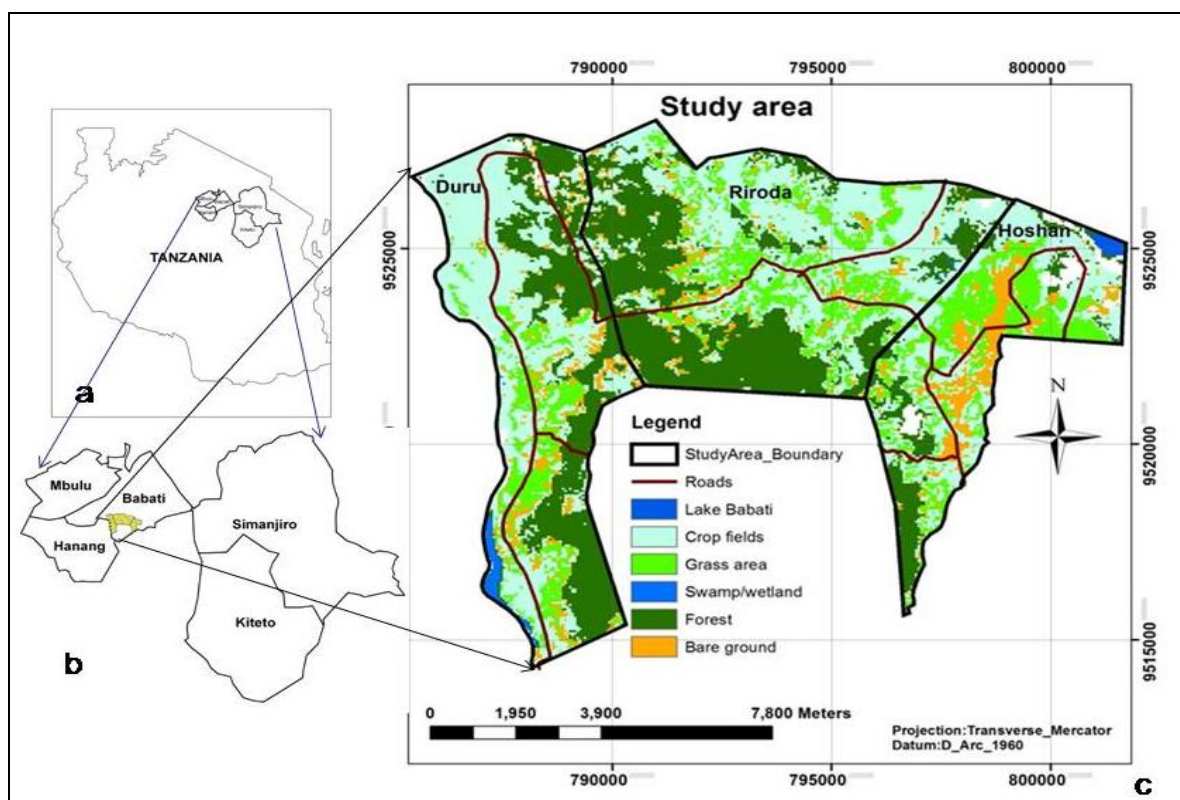


Figure 1:(a) Map of Tanzania showing location of Manyara region<sup>1</sup>, (b) Map of Manyara region showing a study area in Babati district (c) Duru Haitemba community forest image map

The mapping exercise was done in groups of 7-10 villagers who were selected from interviewees in a particular village. Participants for the mapping exercise were selected based on qualities explained by Waters-Bayer and Bayer, (1994) <sup>[39]</sup> and Shrestha, (2006) <sup>[28]</sup> which included involvement in village leadership (Village Executive Officer and sub-villages' chairpersons), longevity in the area, representation by gender, involvement in Village Forest Committee activities, Village Land Council, Community Livestock's Attendants, availability and willingness. Good practices and ethics were considered as explained in Corbett and Rambaldi (2005) <sup>[3]</sup>. The best judgment idea by looking at study area general socio-economic and cultural situation such as open market days was also applied. Systematic random sampling was used to identify 79 heads of households while purposive sampling was applied to select 7 village leaders for interview. The participants were asked to make map on the ground/paper, locally available and acceptable materials, satellite images were used for comparison purpose. Mapping was done to identify former and available grazing resources and conflicts areas.

**Geo-coded transects:** Transect walk were done accompanied by key informants to identify grazing resources, i.e. areas and water points and all grazing related conflicts. Hand-held GPS receiver "Garmin 12" was used to record positions of resources and conflicting areas to ground truth location of areas mentioned and indicated during community mapping.

To confirm what was reported on grazing practices, resources and conflicts during data collection through interview and mapping, field observation was carried out. Site visits can establish accurately if what is reported is correct and true <sup>[22]</sup>. The triangulation technique was used to observe forest's state in line with uses and access, grazing in the forest and in conserved areas.

### Assessment Framework for PGIS in the study

In order to assess potentials and effectiveness of PGIS in this study several indicators were developed. "An indicator quantifies and simplifies phenomena, in addition it helps to understand complex realities <sup>[8]</sup>. To assess the potentials of Participatory GIS in conflict identification and pastoral resources, a planning framework for assessment was developed as shown in Figure 2. Indicators are useful in several ways for this kind of study as pointed out by (Groenendijk and Dopheide, 2003) <sup>[5]</sup>. Indicators assisted to communicate a perception of relevant issue, in line with grazing related conflicts and PGIS applicability. Therefore to determine the potential of PGIS in pastoral resources planning and conflict identification, there was a need to look at what explains the existence of grazing related conflicts like what is required to be known about the conflicts? What are the conflicts about? Who are involved? What resources are involved? And where are they?

### Results and Discussion

**Grazing Related Conflicts:** Prior to field work the study area was looked at as a place with very few or no conflicts

over natural resource because other studies done in Duru-Haitemba by Wily (2001) <sup>[42]</sup>, Kajembe *et al.*, (2003) <sup>[10]</sup> focused more on CBFM dimensions. Responses on the presence and nature of grazing related conflicts identified in the area are summarised in Table 1.

Dormant conflict (9%) means that the conflicts are not actively expressed. The ones mentioned dormant conflicts predicted that with the observed trend of scarce land resources particularly grazing resources without necessary measures to adjust land uses, intensity of conflicts could increase. Active but less violent conflicts existed by 79%. They occur when agro-pastoralists are found by the relevant authorities grazing in the banned areas especially in the forest, and along areas with water bodies'. Some of the respondents (10%) responded that there were no conflicts while 2% did not know if there were any conflicts associated with grazing.

The identified conflicts were basically at intra and inter community scale that was due to differing interests and goals. In addition, factual disagreement and relational aspects as found out by Mostert, (1998) <sup>[21]</sup> were other sources of conflicts whereby agro-pastoralists were dissatisfied over decisions that banned them to graze along areas mentioned earlier. The conflicts were among agro-pastoralists, between agro-pastoralists and farmers, between agro-pastoralists and inter-village authority, between agro-pastoralists and intra-village authority, between agro-pastoralists and district authority as well as Hoshan village versus Endagwe village. Restricted access and use of forest and land resources affected agro-pastoralists as they rely on them for fodders and water. Generally those conflicts were due to limited access and use of grazing resources, conflicting land uses, as well as extending farm and forest boundaries between Hoshan and Endagwe villages. This implies that grazing related conflicts fit in Natural Resources Management (NRM) conflicts.

**Areas with grazing resources conflicts:** Through community mapping, geo-coded transect walk and observation, conflict areas and their causes were identified. The most conflicting areas were spatially found on hilly parts in the forest, Mamahasma salty water area, Lake Babati and along River Bubu green belt and farms adjacent to forest and lowlands. The areas with conflicts are shown in Figures 3 and 4 which display difference between allowed and actual grazing areas. Grazing related conflicts in the study area have been attributed by limited access and uses of grazing resources due to government order on conservation, conflicting land uses like forest conservation, water sources conservation and farm expansion against grazing.

It was further found out that grazing was only allowed on private grazing land and few water points for livestock, (Figure 5). The difference on where agro-pastoralists should graze and where they actually do is considered to be conflicting as it indicates dormant and active disagreement. The areas are considered useful for fodders and

water by livestock keepers but seen as fragile to be conserved by village, ward and district authorities

Studies have indicated that in NRM conflicts partly occur due to difference of perceptions, interest, goals, system structure and social relations of power [14,21,30].

As shown in the two maps (Figures 3 and 4) legally acceptable grazing resources in the studied villages are few as indicated in the allowed grazing areas. This is contrary to daily grazing practice because areas which agro-pastoralists use for grazing were in the forest and close to areas under conservation, black circles in Figure 4 highlight those areas.

### Identification of Grazing Resources through PGIS

Through mapping exercise participants were able to identify available grazing resources such as shared water points, privately owned grazing areas and cattle tracks “mapario”. Through the observation of points which were recorded during transect walk, it was proved that grazing resources identified during participatory were in the same locations. Figure 5 is a map showing the grazing resources identified in the study area.

Basically there were private grazing areas, functional and dried water points, and cattle tracks “mapario”. During mapping and through discussions with participants, it was discovered that there is limited access and uses in the forest and water sources areas. Besides, there was no communal grazing land in any of the villages apart from Duru where some sub-villages’ chairpersons allowed their people to graze in some parts of the forest which is contrary to community based forest management’ by-laws. Due to scarce grazing resources, it was reported that no village is sharing forest and other grazing resources with another village.

Rights to use and access natural resources become more specific as their scarcity increases [31]. During data collection in the field, it was found out that water points and cattle tracks are resources that were shared within the villages.

However there were disparities, as it was unanticipated to find that agro-pastoralists in some sub-villages that are in the same village do not share grazing resources. For instance Mamahasma sub-village in Riroda do not share grazing resources with other sub-villages in their village.

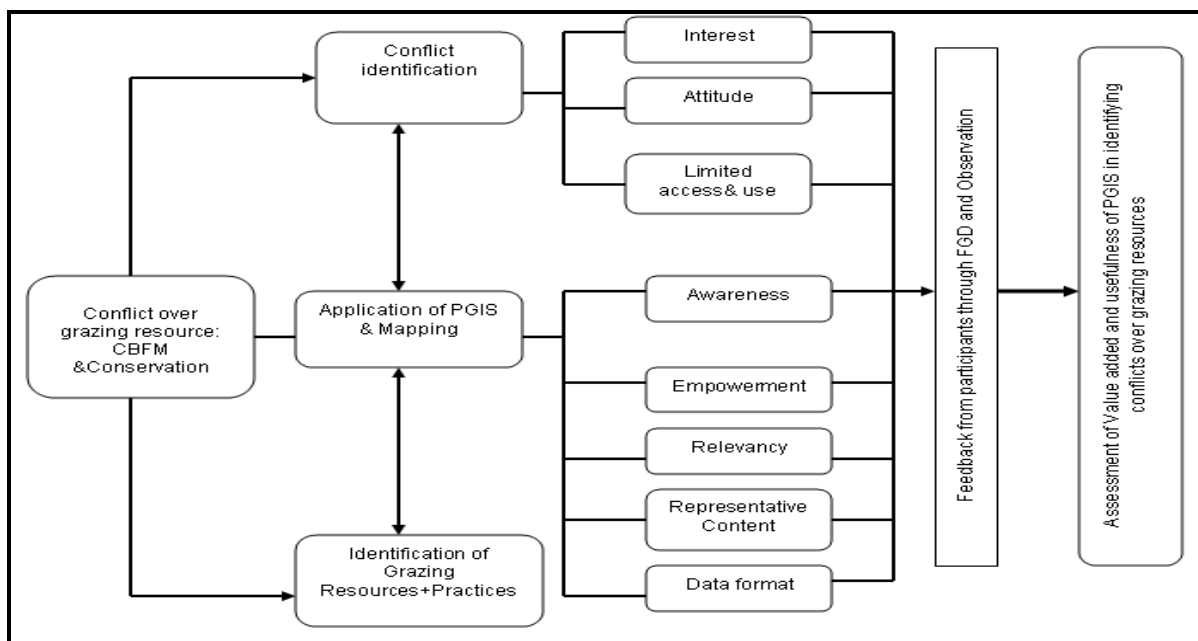


Figure 2: Assessment framework for usefulness of PGIS in the study

Table 1  
Presence and nature of conflicts in the study area

Nature of conflict	Number of respondents	Percentage
Dormant	7	9
Active but less violent	68	79
No conflicts	9	10
Do not know	2	2
<b>Total</b>	<b>86</b>	<b>100%</b>



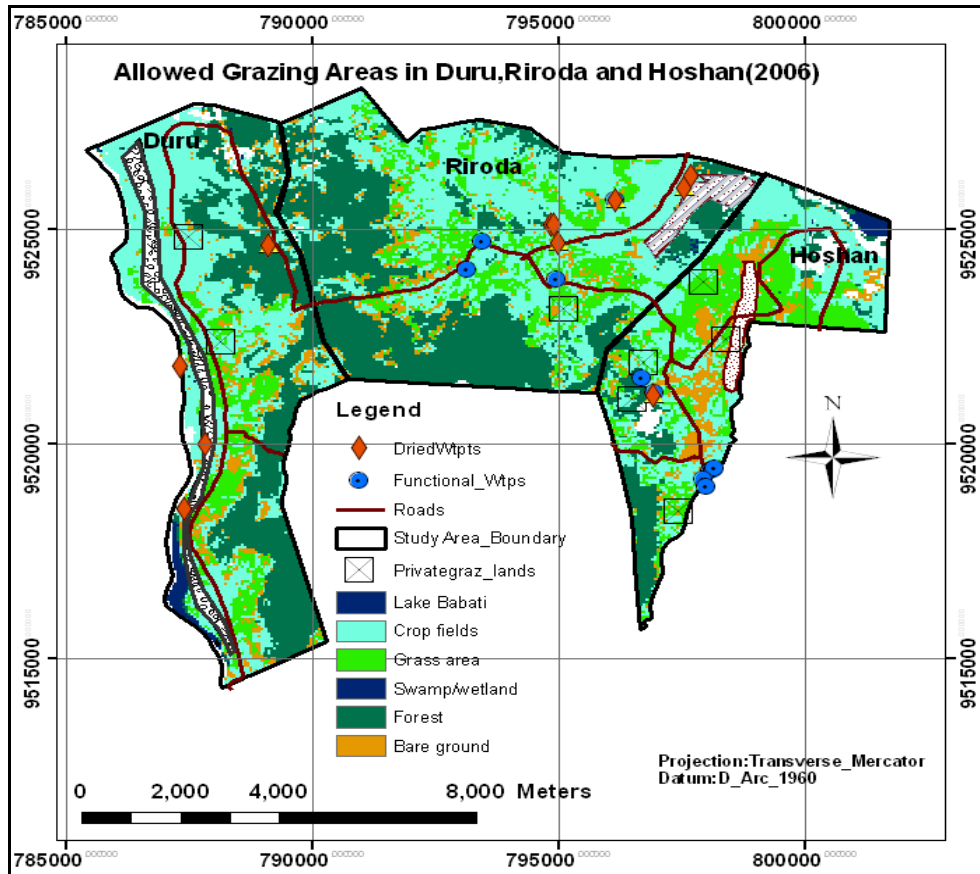


Figure 3: Allowed grazing areas

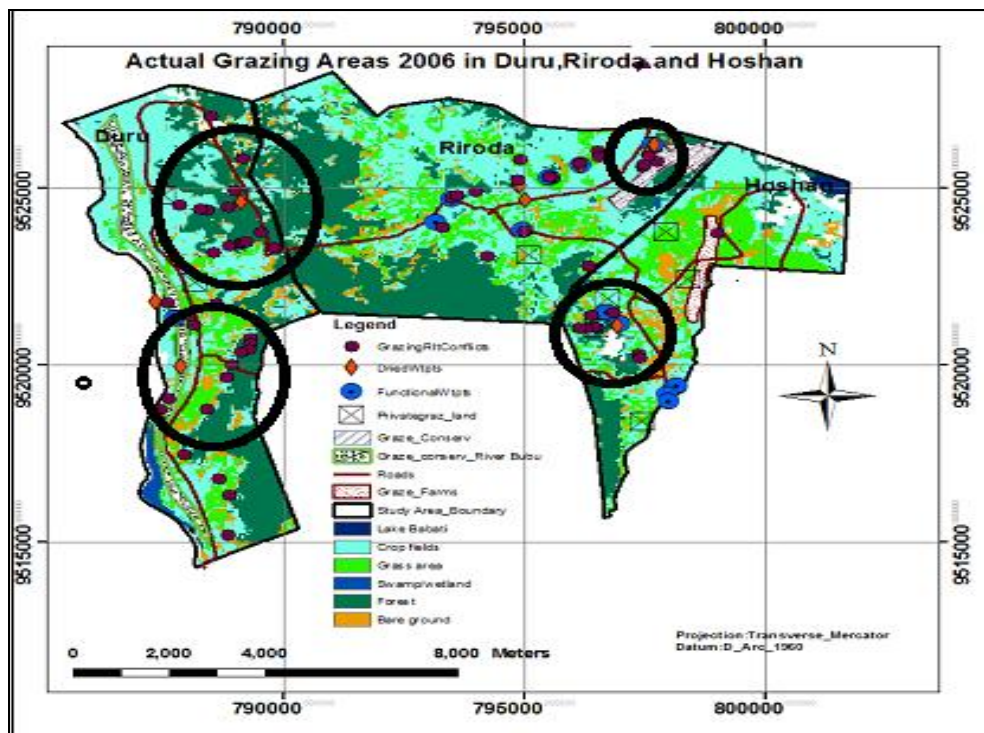


Figure 4: Actual grazing areas

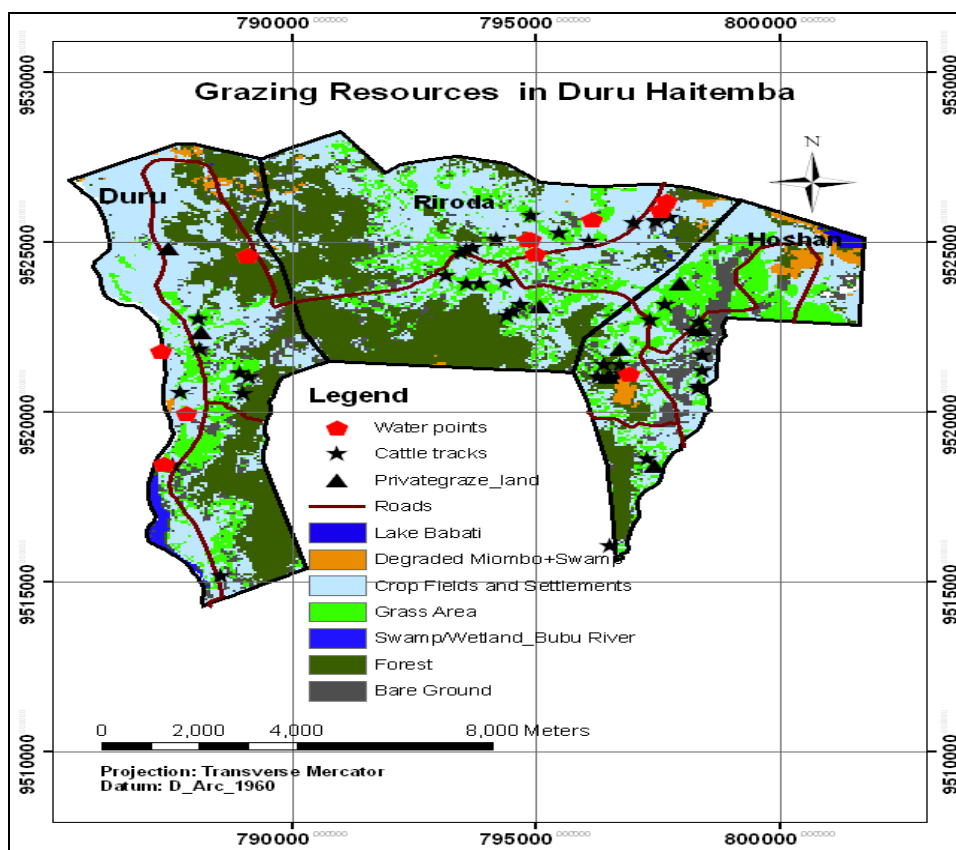


Figure 5: General grazing resources in the studied villages

**Former and available grazing lands:** Former grazing lands in Duru-Haitemba villages have been converted into farms and under conservation programmes. For instance, in Hoshan in December 1996 about 134 acres were distributed to villagers as farms based on the villagers' request for farmlands. As from 2005, about 200 acres which were formerly used for grazing was converted to conserved areas. Human activities including grazing were banned in this area which was located close to green belt zone in Riroda village.

It was found out that since 2005, directives on banning human activities along the areas became more serious with close supervision from the district council. Privately donated 1.5 acre where livestock water points are located in Riroda is very small for the number of livestock available in three sub-villages that were given the land. In Hoshan and Riroda the areas under conservation included "Mbuga Pongay", the area with shrub and grasses almost throughout the year which was used for grazing. In Duru it was described that there has been change of communal grazing land which was close to River Bubu but documented records on size of the area could not be obtained. There was difference in Duru village on the issue of grazing in the forest as some of the sub-villages chairpersons' allow the villagers to graze in some parts of the forest especially at the edges. Figure 6 and 7 shows that before 1995 agro-pastoralists had relatively free access to the forest.

They could at least graze in the forest since they considered it as government property and not their own. The

maps show change in grazing areas, as after ban grazing in the forest in 1995, the only alternative was swampy and watery parts along areas with water bodies and sources (Pongay shrubby areas, River Bubu and Mamahasma lowland). But due to population increase, farm expansion and conservation policy, remaining grazing areas were converted into farms and conservation areas. Before CBFM villagers were to a great extent free to graze in the forest. During the fieldwork it was observed that some parts of River Bubu which in the past years were covered by water had become almost dry to the extent that villagers could easily to cross to the neighbouring villages of Hanang district. The above Land Uses Land Cover (LULC) maps of 1995 and 2006 were prepared from ASTER images. The images were acquired, processed and classified using ERDAS Imagine 8.6. Accuracy assessment was done based on GPS ground truth points, the accuracy score was 86% which is acceptable as it is above 80%.

**Relationship among Spatial temporal factors towards conflicts:** In Tanzania there are two major seasons for grazing namely rainy and dry season<sup>[29]</sup>. There is relationship between seasonality and grazing, where and when to graze is influenced by season in time<sup>[12,32]</sup>. Since the study area experience semi-arid type of climate, rainfalls are erratic and sometimes the dry season extend much longer. The seasonal climatic changes affect livestock keeping<sup>[16]</sup>. This study found out that during rainy season, pastures and water are obtained close to home-yards. The same was found in the study by Lindström and Kingamkono (1991)<sup>[16]</sup>.

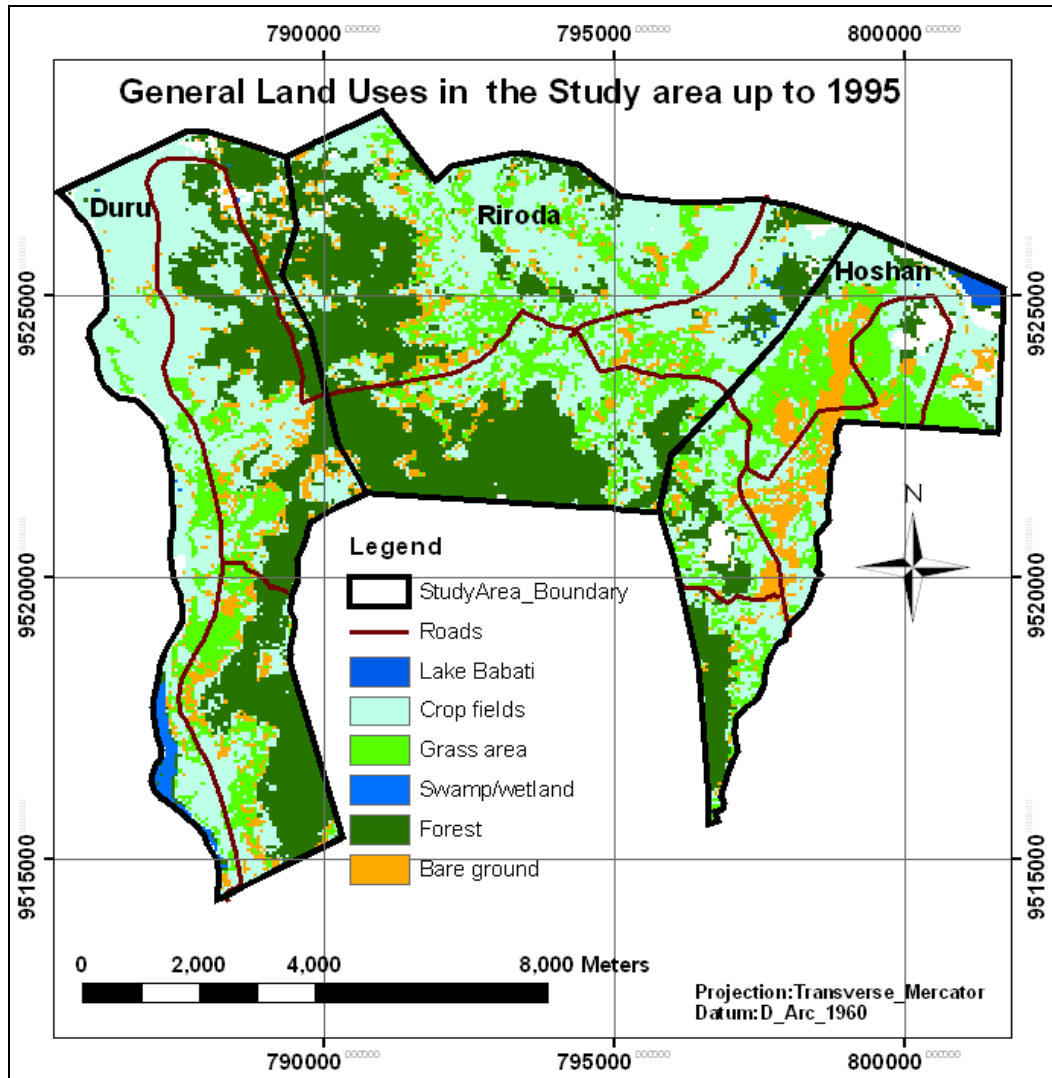


Figure 6: General land uses up to 1995

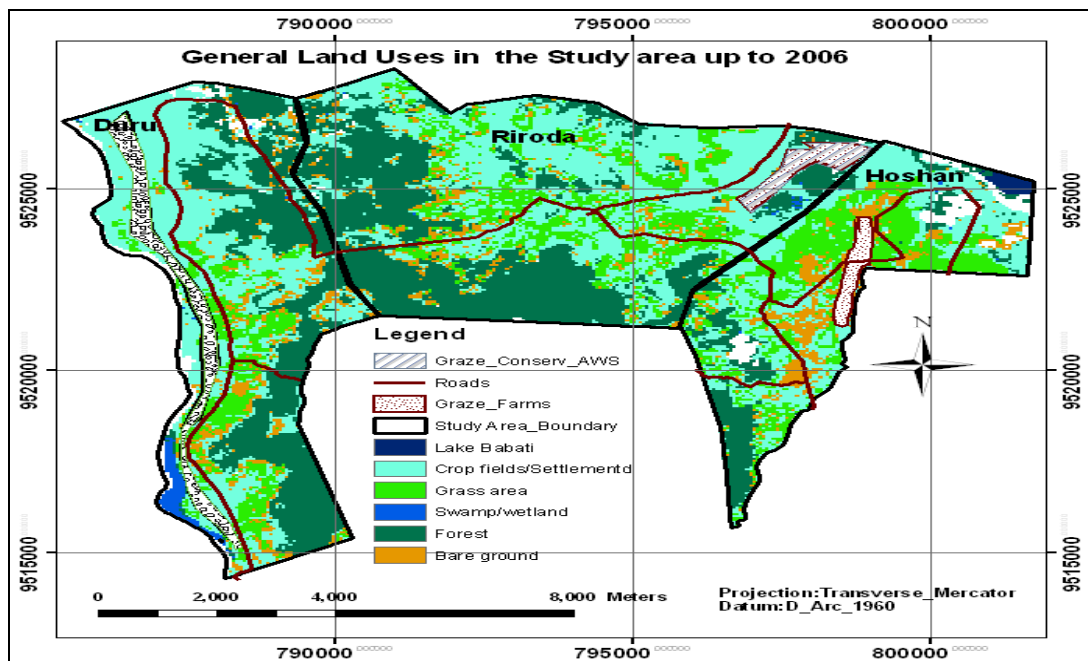


Figure 7: General land uses up to 2006



The conflicts identified in this study are associated with dry and rainy seasons. During rainy and farming season normally Jan-May/June grazing in the farms is relatively impossible because there are crops in the fields. By-laws on CBFM stipulated that grazing in the forest is not allowed. In addition grazing along Lake Babati, River Bubu and Mamahasma area is prohibited in order to conserve water bodies and sources.

Thus more conflicts occur during rainy season as proved through Villages Fine books whereby there were 6-8 cases of grazing in prohibited areas per month. From the interview 80% of the respondents mentioned more occurrences of grazing related conflicts during rainy season and out of them 39% specified that there were 5-16 cases on grazing in banned areas. There is a difference on the number of cases from household interviews and village records, which implies that some people graze in banned areas especially in the forest without being noticed. Figure 8 illustrates that cases related to grazing in the forests are high in number during rainy season. This is partly contributed by lack of communal grazing land in the study area and the fact that during rainy and farming season grazing in the farms is hardly possible.

During dry season and perhaps short rains normally in June/July- December which is time for harvesting and post-harvesting, grazing conflicts are reduced to some extent due to availability of fodders coming from crop residues. But the crop residues do not completely substitute other sources

of fodders because majority own 1.5-8 acres of farmland which is small to provide adequate crop residues.

Water for livestock becomes a challenge during dry season. Water is obtained close to Lake Babati, Bubu river and Mamahasma area where grazing is not allowed. Taking into account that the study area experience semi-arid climate many livestock water points dry up easily during dry season.

The relationship between spatial temporal factors that influence conflicts can be established based on where agro-pastoralists graze throughout the year as indicated in Figure 8.

Figure 8 show that crop residues are mainly used as grazing resources during dry season (June/July- December). In this season there are no crops in the fields so livestock keepers could freely graze animal there. It can also be noted that the forest is used as main grazing area during rainy season (Jan-May/June) although it is illegal. Absence of communal grazing land, high season for farming and owning small farms enough to set aside private grazing land have influenced agro-pastoralists to graze more in the forest during rainy seasons. Figure 8 illustrate that along the road is another option for grazing, next to forest during rainy season. Spatially, conflicting areas were found in areas where grazing is not allowed but essentially agro-pastoralists do graze. Note, though total respondents (N) is 86 in Figure 8 the responses exceeded it due to multiple responses.

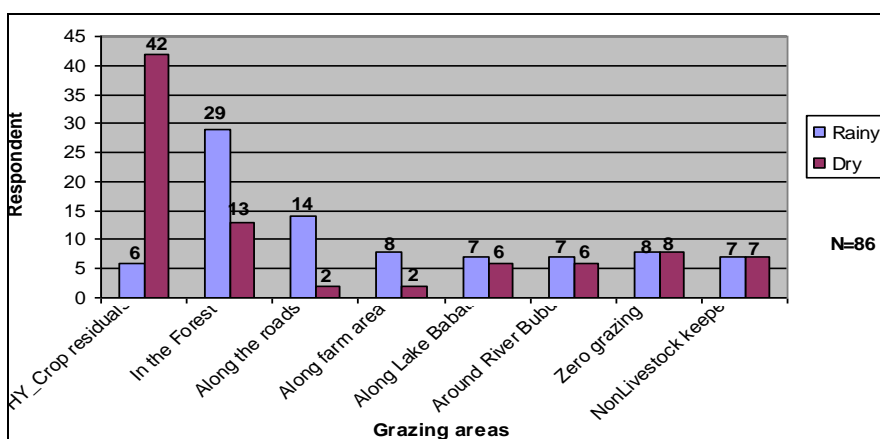


Figure 8: Grazing areas during rainy and dry seasons

Table 2: Mapping participants' observations on evaluating the role of PGIS

Statements under evaluation	Average score	
	Before mapping	After mapping
PGIS as a tool facilitate comprehensive discussion among community members	2.0	4.0
PGIS useful to identify grazing areas/resources	2.2	4.1
Analysis of grazing resources` uses and access	2.1	3.9
PGIS helps in identifying conflict areas in Participatory manner	2.1	4.0
PGIS help to make more detailed mapping	2.0	4.2
Scale: Strongly agree=5, Agree=4, Neither= 3, Disagree=2, Strongly disagree =1		

### **Evaluation of participants attitudes' towards usefulness and added value of PGIS:**

Attitude of the participants on PGIS towards the usefulness of the PGIS was evaluated before and after mapping exercise. The attitudes were evaluated based on Likert scale <sup>[2]</sup>. Statements on the usefulness and added value of PGIS to be evaluated were presented to the participants during the Focus Group Discussion (FGD). These statements to be evaluated addressed several issues such as facilitation of comprehensiveness of discussion, usefulness/relevancy in identifying grazing resources, and analysis of uses and access of grazing resources, participatory conflict identification and production of detailed maps. The answers to each statement to be evaluated based on Likert scale were five and were given numbers ranging from 1 to 5, see Table 2 for the meaning of the numbers 1 to 5. Note that it is only the final average score calculated based on Likert scale are presented in Table 2.

Average score for all the statements under evaluation before participatory mapping show that, all participants disagreed on the usefulness and added value of the PGIS in this study, (average score = 2.0 to 2.2). However, after participatory mapping the participants agreed (average score = 3.9 to 4.2) that PGIS can play important roles in relation to its ability to facilitate comprehensiveness and identification of grazing resources. The results in Table 2 indicate that, the participants in this study changed their attitudes from "disagree" to "agree" on the roles, usefulness and added value of PGIS. In addition, participants were able to identify conflicting areas in a participatory manner, through mapping participants were able to come up with more detailed village maps compared to existing ones. Community mapping motivate participation hence output maps become more representative of the actual situation in resources and land uses in local people perspectives.

Through community mapping (PGIS) much of how and why people live in the study area in line with their livelihood (agro-pastoralists) has been revealed. (McCall,2004, McCall,2008,Vajjhala, 2005) <sup>[18,19,37]</sup> reported the same and explain that how people live with social and economic attributes is strongly connected to participatory mapping, while conventional GIS is strongly associated with where people live. Essentially community mapping and PGIS proved to be useful tool for examining spatial temporal distribution of conflicts/conflict area, as observed during mapping exercises, FGD and evaluation after the mapping. Furthermore, the exercise has raised more awareness and empowered community through knowledge sharing on mapping and different dimensions of CBFM.

### **Conclusion**

Grazing resources identified through PGIS in Duru-Haitemba villages included shared water points, privately owned grazing areas and cattle tracks. These resources are scarce and hence the villages have been found to be characterised by two types of conflicts namely dormant and active but less violent. However, active but

less violent conflict dominates the area since it is the conflict among the pastoralists and authorities who restrict them from grazing in banned areas. There is a limited access and use of grazing resources, conflicting land uses and extension of farms and forest boundaries. Grazing resources are decreasing in the study area. Conflicts over NR are inevitable especially where resources are scarce and used by different groups for different use to sustain their livelihood. Policies and directives on conservation taken at national level can have different effects at local levels in terms of location, time and context. Conflicts (dormant and active) occur partly due to less participatory or non-participatory plans and decision making. Variations in perceptions over ownership from different actors, number of actors in the conflicts and time influence conflicts escalation or de-escalation.

PGIS can be used to identify grazing resources, pastoralists' uses and access interactions as long as the framework for assessment of PGIS usefulness is well prepared and logically used during the process. The assessment starts with conflicts, grazing resources and practice identification and mapping in a participatory way, it also involved setting indicators and getting feedback from the community members and observation of what the participants identified. It ends with assessment of the value added and the usefulness of the PGIS in conflicts identification over grazing resources.

PGIS approach, despite of its challenges, is useful and appropriate in this study as it has enabled to visualize grazing resources and conflicts in local context. Besides, it added on geo-spatial information and gave answer to 'why' and 'how' people live in a specific area, identify internal and external features of conflicts, the information which could hardly be obtained through conventional GIS and remote sensing. Nevertheless mapping processes need to be well organized and focus much on the input of local people because they know their localities better than outsiders. Participatory mapping exercise has raised more awareness and empowered community through knowledge sharing on mapping process. After the attitude of participants was evaluated using Likert scale the attitude had changed from "disagree" to "agree" that PGIS can play important roles in relation to its ability to facilitate comprehensiveness and identification of grazing resources. In this study PGIS have effectively managed to identify and explain the relationship between spatial-temporal factors and the nature, frequency and magnitude of grazing resources' use conflicts were found to be higher in rainy season than in dry season because during the rainy season grazing resources availability is limited as there are crops in the farms.

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