FRIM NEWS

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Editorial

The Forestry Season (Tree Planting Season) is fast approaching in the country. In the spirit of forest landscape restoration, let us all join hands to restore those degraded areas to make our country green again. This effort will also go a long way in climate change mitigation. Memories are still fresh with key outcomes from the recent Conference of Parties (COP 26) that took place in Glassgow, Scotland. COP 26 was the latest and one of the most important steps in the decade's long, UN-facilitated effort to help stave off what has been called a looming climate emergency. It is now time for action after that talk show if we are to make a difference. One of the biggest and encouraging announcement at the COP 26 was that leaders from over 120 countries, representing about 90 per cent of the world's forests, pledged to **halt and reverse deforestation** by 2030, the date by which the Sustainable Development Goals (SDGs) to curb poverty and secure the planet's future are supposed to have been achieved.

It is encouraging to learn that Adaptation was the object of particular emphasis during the deliberations. Parties established a work programme to define the global goal on adaptation, which will identify collective needs and solutions to the climate crisis already affecting many countries. Finance was extensively discussed throughout the session and there was consensus on the need to continue increasing support to developing countries. The call to at least double finance for adaptation was welcomed by the Parties. The duty to fulfill the pledge of providing 100 billion dollars annually from developed to developing countries was also reaffirmed. On mitigation, the persistent gap in emissions has been clearly identified and Parties collectively agreed to work to reduce that gap and to ensure that the world continues to advance during the present decade, so that the rise in the average temperature is limited to 1.5 degrees.

EFFECT OF INVASIVE ALIEN PLANT SPECIES ON SOIL PROPERTIES AT NYIKA PLATEAU AND MULANJE MOUNTAIN – COMPARATIVE STUDY

Innocent Taulo

Significant hectares of grasslands at Nyika Plateau National Park and Mulanje Mountain were invaded and are currently dominated by *Pteridiun aquilinum (Bracken fern), Pinus patula* (Mexican pine), *Rubus ellipticus* (Himalaya Raspberry) and *Acacia mearnsii* (Black wattle). Part of the success of these invaders is due to their expanded temporal niche breadth relative to native plants in these areas, but it may also result from persistent invasion-mediated shifts in the biotic and abiotic soil environment. These shifts can complicate ecological restoration (Suding *et al. 2013), and management strategies that suppress one* invader often result in the establishment of a second invader (Simberloff *et al. 1999). Even in the absence* of direct competition from invasive plants, diverse native communities are difficult to restore in soils that once supported invasive plants (van der Putten *et al. 2013).* At a local scale, the strong impacts of introduced species are wide and different, impacting at different levels. For instance, invasive species alter and modify ecosystem structure by altering composition and community structure of invader areas (Ehrenfeld & Scott 2001).

The change in species composition of communities have effects on ecosystem process. Therefore, invasive species by additions of new ones, substitution of one or more native species, or loss of native diversity, alter ecosystem processes. These changes on ecosystem dynamics may have cascading effects on other species and may affect the potential for restoration (Ehrenfeld & Scott 2001). Therefore, invaders are associated with consisted changes in soil biotic properties. Invasive plants can push native grassland soils into invader specific ecological states that are consistent across the sites.

Forestry Research Institute of Malawi (FRIM) and Environmental Affairs Department (EAD) jointly conducted a baseline study on Mulanje Mountain and Nyika Plateau for Invasive Alien Species Management Project (IASMP) to understand how invasive alien plant species *Pteridium aquilinum (Bracken fern) Pinus patula* (Mexican pine), *Rubus ellipticus* (Himalaya Raspberry) and *Acacia mearnsii* (Black wattle) affect the chemical properties of soil upon their infestation.

Results of the study showed that soils on Mulanje Mountain had very low levels of Phosphorus. Despite this, there is some variations among the soil under different invasive species. A case in point is soils under *Rubus elipticus* which indicated relatively closer to the critical value (8mg kg^{-1}) as compared to rest of the invasive species. However, there were slightly and consistently low levels of Phosphorus available for plant uptake on all the soil under invasive plant species at Nyika plateau. It is therefore suggested that the primary cause for the low levels of available P is owing to the extreme acidity and high levels of Calcium. Low soil pH severely limits the availability of P for plant use. had indicated average pH level of below 4.2 and Calcium of greater that 3000mg kg^{-1}.

Other Services offered by Forestry Research Institute of Malawi

- Supply of certified Tree Seed and Seedlings;
- Seed Testing Laboratory Services;
- Soil Laboratory Services;
- Tree Pathology Laboratory
- Services;
- Economic Valuation of Trees;
- Consultancy Services in Forestry and Environment.

Figure 1. Atomic Absorption Spectrophotometer (AAS) machine used in analyzing various elements of interest

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In terms of soil ph, all the soils sampled from Mulanje Mountain had pH levels below 4.2 and 37.5% of the samples had pH of below 4.0. This signifies that soils on Mulanje mountain were strongly acidic. On the other hand, the pH levels for Nyika plateau, was preponderant in soils under *Rubus ellipticus* (4.7) and lowest in *Pinus patula* (3.7). Soil pH for soils under Bracken fern was slightly reduced from 4.2 (grassland) to 3.8 (Bracken fern). This underscores that natural bracken fern biomass has an acidifying effect on soil solution as found by Maynard *et al*. 1998**.** Among all the invasive plant species, *Pinus patula* recorded reduced soil pH there by increasing the soil acidity from 4.2 (Grassland/control) to 3.7. It is therefore suggested that among other factors, the decaying of organic matter (pine needles) produces H^+ which is responsible for acidity. Nonetheless, excessive rainfall which is an effective agent for removing basic cations over a long time, had influenced the overall acidity levels of soils at both study sites (Nyika plateau and Mulanje mountain). Rainfall is most effective in causing soils to become acidic if a lot of water moves through the soil rapidly.

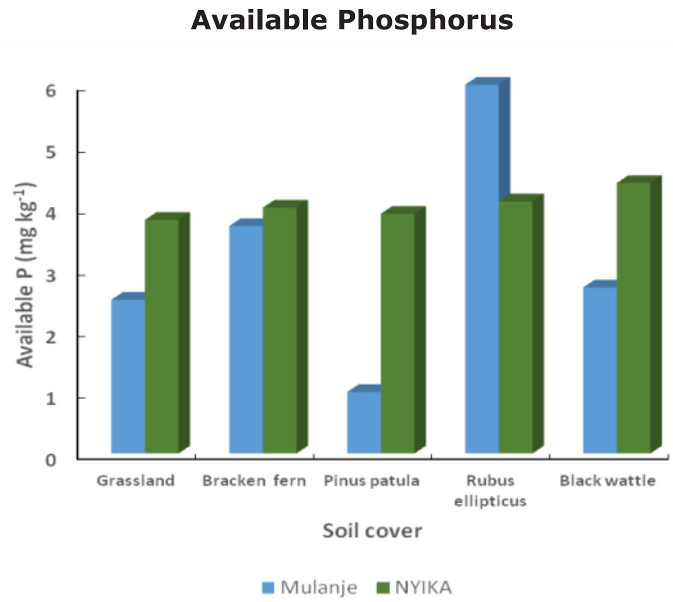

Figure 1: Available Phosphorus under different invasive species

Total soil organic Carbon from both Mulanje Mountain and Nyika Plateau were also analyzed. Soils from Mulanje Mountain recorded higher total organic Carbon (3.1%) in soils under *Rubus elliptucus* and Bracken fern (2.7%) than the other invasive species which indicated medium levels of total OC. All soils under invasive species at Nyika plateau had very high total organic carbon (≥2.3%). Nevertheless, extreme concentration of OC was observed in *Pinus patula.* Generally, Nyika Platuea, had higher levels of Organic Carbon than Mulanje Mountain under all invasive species studied except for soils under *Rubus ellipticus*.

In conclusion, the study has revealed that while invasive species can alter the abundance or diversity of species that are important, some invasive species are capable of changing soil chemistry in an ecosystem. Invasive species are capable of causing extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats. This can result in huge economic impacts on the forest sector due to loss or reduced efficiency of production and fundamental disruptions of mountain ecosystems with accompanying changes in the availability of resources such as water and nutrients.

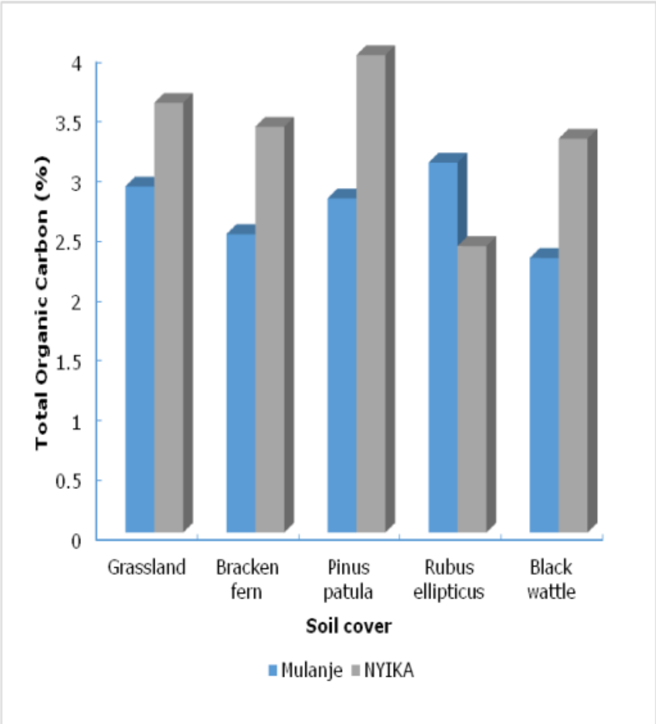

Figure 3: Variation of soils total organic carbon

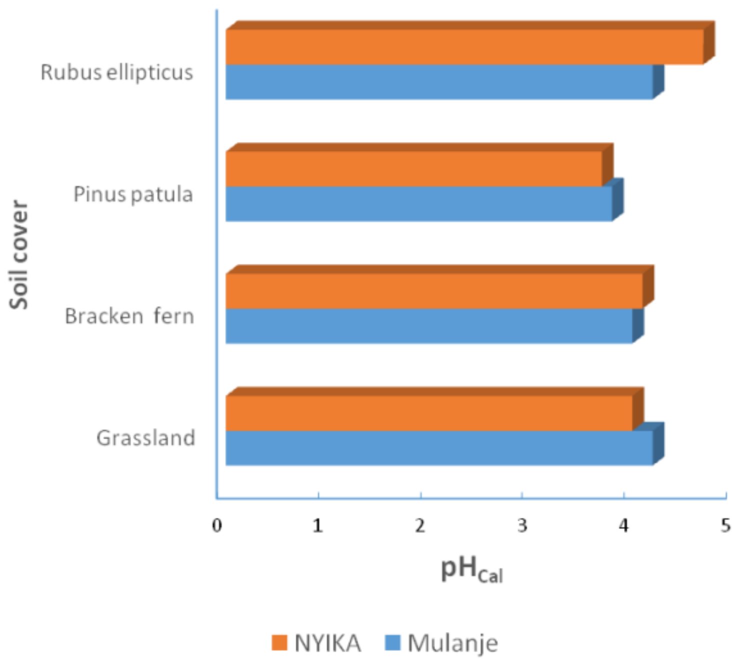

Figure 2: pH levels across areas under invasive alien plant species

VILLAGE WOODLAND DIVERSITY AND CARBON STOCK IN MANGOCHI

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Forests on customary land are an interesting case as they too contribute to carbon sequestration. In Malawi and the entire *Miombo* eco-zone, *Miombo* woodlands are considered an important element in global climate change mitigation programs such as the REDD+.

The introduction of 'Energy Forests for Malawi' Project in Chilipa, Namavi and Nankumba in Mangochi, sought to promote sustainable Village Forest Area (VFA) management activities to increase forest cover, productivity and value, as well as ensure continuous provision of goods and services. Additionally, it sought to improve livelihoods of forest dependent communities through sustainable forest management and utilization. The project supports baobab collectors and sellers, so that they can learn to conserve their forests and sustain organic fruits production. The project therefore conducted Welthunger village forest area inventory in the six (6) VFAs of Kamenya, Namikango, Namizimu, Nankulukutiche, Nyala ya Milongwe and Sodzi in Mangochi whose objectives were to:

- Estimate carbon stocks in the village forest areas;
- Provide regeneration dynamics of the VFAs; and
- Improve the VFAs' governance arrangements.

The assessment team used the guidelines and Standard Operating Procedures (SOPs) being used during National Forest Inventories (NFI) in Malawi to collect data from the VFAs. For the purposes of this study, the species of all sampled trees were noted. Height and diameter for each tree was measured using a vertex and calibrated diameter at breast height (DBH) measuring tapes respectively. The data collected was used to estimate tree species composition, diversity, dominance, evenness, carbon stocks, and evaluate species regeneration. In this study *Shannon-Wiener Index of Diversity (H')/ Simpsons Index of Dominance (D)* was used. Above ground biomass (AGB) and below ground biomass (BGB) of a tree were estimated using site-specific equations developed by (Kachamba *et al.* 2016) while biomass was converted to carbon stocks using IPCC methods and a conversion factor of 0.5. A total of 57 plots across the project impact areas were sampled and assessed.

Species diversity

A total of 1455 individuals and 104 species were identified across the six VFAs. Different tree species were recorded with none more dominant than *Adansonia digitata, Diplorhynchus condylocarpon* and *Brachystegia bussei.*

Species richness gives equal weight to species with few individuals as it does with species with many individuals. It does not take into account the abundance of the species or their relative abundance distribution (McGill, *et al.* 2007). The metric of richness is computed as the number of species in each plot and for each area. Whereas, species composition is the relative contribution of individual species to the total composition of trees in each plot and for each entire forest area. Composition is computed based on density, which is the total number of trees sampled in hectares. Evenness compares the similarity of the population size of each of the species present. Species evenness is considered as the measure of equality of abundances in a community. It ranges from zero to one, with zero signifying no evenness and one, a complete evenness.

Diversity Indices

Of the 6 VFAs, Nankulukutiche is the most diverse with a Shannon-Weiner index of 3.38 and Namikango (2.5) is the least diverse of the 6 VFAs (Table 1). The higher the diversity in a particular forest area the more chances of survival of the forest. The results, however, show that all the 6 VFAs are diverse enough when even regenerants are considered. The results also show that species such as *Adansonia digitata* and *Diplorhynchus condylocarpon* which are native to the study area are dominant. However, species such as *Adansonia digitata* are difficult to raise and communities do not prefer to raise them for planting. For instance, at Kamenya it was observed that communities prefer to plant species such as *Albizia lebbeck* (Mtangatanga).

A diversity index is a quantitative measure that reflects the number of different species and how evenly the individuals are distributed among those species (Jost 2010). Shannon's diversity index (H) is a measure of heterogeneity, involving species richness and equitability. This Index is most widely used because it combines species richness the relative abundances of species, it is not affected by sample size (Jost 2010). The Simpsons Index of Dominance (D) on the other hand measures the distribution of individuals among the species in a community. Dominance is defined as relative importance of a species related to degree of influence it has on ecosystem components such as soils, other plants and animals.

Regeneration and mature tree count

The recorded regenerants in Kamanya VFA are more than the mature trees which is expected in a normal forest for smooth succession. This is a good example of the inverse J-curve phenomena for succession of tree species. The seedlings count is an indicator of the future of the VFA. The results (Figure 1) show that in Nankulukutiche and Nyala ya Milongwe VFAs, tree seedlings are almost equal to the mature trees inventoried. This could be attributed to tree poaching where trees of value are cut or removed illegally for charcoal production or timber.

Biomass and carbon estimations

Nyala ya Milongwe VFA had the highest carbon tonnage (123.7 tc) where as Kamenya VFA recorded the least (5.4 tc) (Table 2). This can largely be attributed to the tree volume/count in Nyala ya Milongwe. The high tree count in Nyala ya Milongwe is a result of a robust governance arrangement where all community members are vigilant in protecting their VFA from illegal activities.

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Table 1. Species diversity

Diversity Index	Kamenya	Nami-kango	Nam-izimu	Nankulu-kutiche	Nyala ya Milongwe	Sodzi
Species richness	33	32	30	42	31	44
Shannon-Wiener Diversity Index (H')	2.7757	2.5230	2.9466	3.3827	2.8662	3.1888
Simpson's Index of Diversity (D)	0.1018	0.1843	0.0793	0.0442	0.0954	0.0736
Species evenness (EH)	0.7939	0.7216	0.8427	0.9675	0.8197	0.9120

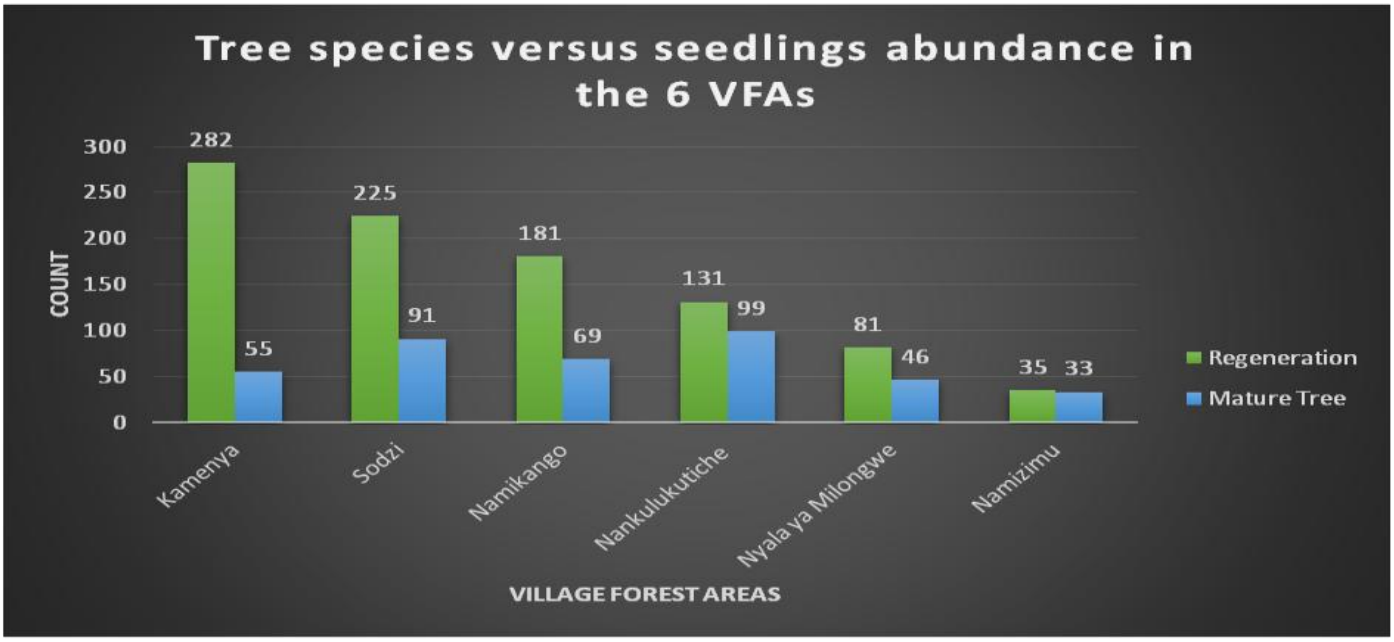

Figure 1. Mature tree species versus seedlings abundance

Table 2. Biomass and Carbon estimation

VFA	Above Ground Biomass (AGB)		Below Ground Biomass (BGB)	
	Volume (Kg)	*tC per ha*	*Volume (Kg)*	*tC per ha*
Kamenya	2,310.45	5.35	1,325.26	3.43
Namikango	43,619.05	20.86	13,552.30	8.47
Namizimu	30,977.93	25.47	12,337.05	11.96
Nankulukutiche	118,234.86	52.21	40,578.66	20.39
Nyala ya Milongwe	142,784.88	123.67	33,887.87	29.17
Sodzi	62,799.85	28.51	21,616.85	12.17

In conclusion, *Adansonia digitata, Diplorhynchus condylocarpon* and *Brachystegia bussei* were identified as the most dominant species in the six (6) VFAs. Nankulukutiche is the most diverse yet all the 6 VFAs are diverse enough when regenerants are considered. The study has shown that all the 6 VFAs are diverse enough even when regenerants are considered. The study has revealed high species composition coupled with high species diversity and evenness across the VFAs which is good for sustainability as there is a chance of species survival in the event that other species shrink their niche due to climate change effects or are threatened by other ecological changes. It is important to emphasize that despite the potential of seedlings to replace the mature trees, demographic pressure within the VFAs may disrupt tree succession process overtime. It is thus expected that due to selective tree poaching, a different species profile may take over. High carbon tonnage sequestered in a forest is a positive contribution towards global climate change mitigation. The role of forests in climate change mitigation is globally well recognized. As such, estimation of forest biomass is the first step towards calculation of carbon stocks and this may be replicated in all other forest management units to generate and update the much needed national data on carbon stock.

FLOOD RISK IN THE LAKE CHILWA BASIN

Willie Sagona

Estimation of flood frequency is critical in the design of hydraulic structures, flood plain zoning and economic estimation of flood protection projects. Rare flood events such as the one experienced in the 2014/15 hydrologic year are always extreme in nature and are destructive to life and infrastructures. However, lack of hydro-climatic data at the desired spatial and temporal scales in flood prone areas has been one of the factors hindering flood estimation in Malawi. Most flood-plain communities are not prepared for future disruptions due to lack of information and prediction tools. Such being the case, Malawi is one of the countries considered vulnerable and poorly prepared for extreme events such as flooding and droughts. Regional flood frequency analysis (RFFA) whose aim is to improve estimation at some ungauged sites through the use of information at other gauged sites with long record data in a homogenous region is commonly used to provide information at sites with little or no data available. Such knowledge is very critical as the effects of climate change and variability on floods will also occur alongside other environmental change processes. To predict flood events in the Lake Chilwa basin region, flood frequency analysis was done to assist in flood risk management and preparedness using robust procedures.

Quantile estimates for the Lake Chilwa basin region were used to estimate at-site flood magnitudes using Generalized normal (GNO) for various return periods on the gauged rivers of Mulunguzi, Domasi, Likangala, Thondwe, Namadzi, Phalombe and Naisi. It was observed that the floods for Mulunguzi and Thondwe rivers are almost identical in terms of flooding up to 1000 years return period; while those of Domasi and Likangala; Namadzi and Phalombe Rivers' flood discharge are not far from each other. Naisi River seems to be following its own flow pattern in terms of flooding in all the listed reference return period.

Table 1. At-site estimated floods with reference to specific return periods for the gauged rivers in Lake Chilwa basin

Return Period (Years)	Mulunguzi (m^3s^{-1})	Domasi (m^3s^{-1})	Likangala (m^3s^{-1})	Thondwe (m^3s^{-1})	Namadzi (m^3s^{-1})	Phalombe (m^3s^{-1})	Naisi (m^3s^{-1})
2	11.07	14.6	16.44	11.10	0.37	0.09	5.88
5	25.06	33.06	37.23	25.13	0.84	0.21	13.32
10	33.41	44.08	49.63	33.50	1.12	0.29	17.76
20	48.21	63.60	71.61	48.34	1.62	0.41	25.62
50	72.77	96.00	108.10	72.96	2.45	0.62	38.68
500	95.72	126.28	142.19	95.97	3.22	0.82	50.88
1000	122.81	162.02	182.43	123.14	4.13	1.05	65.28

Likewise, flood estimates were done for Sombani River which is poorly gauged. Using regional growth curves, floods for ungauged rivers of Likwenu, Lingoni, Bwaila (in Zomba), Mponda, Songani, Namiwawa, Khongoloni and Migowi were also accurately estimated up to 500 years return period and beyond this point the results became less accurate. The results show that Likwenu River in Machinga and Namiwawa River in Zomba dominate in terms of high estimated flood records throughout the reference return periods. The two rivers have high estimated flooding records of 302.39 m^3s^{-1} and 263.68 m^3s^{-1} respectively at 50 years return period than the rest of ungauged rivers mentioned above.

The National Disaster Management Plan for Malawi lists Likangala and Thondwe rivers as being very vulnerable to flood hazards and this was reflected in the study. Likangala and Thondwe recorded the second and third highest average river discharge at 40.76 and 34.55 m^3s^{-1} respectively after Domasi River (50.73 m^3s^{-1}).

Choosing to adapt — the future choices

If we fail to adapt to global warming and climate change — we cease to exist!

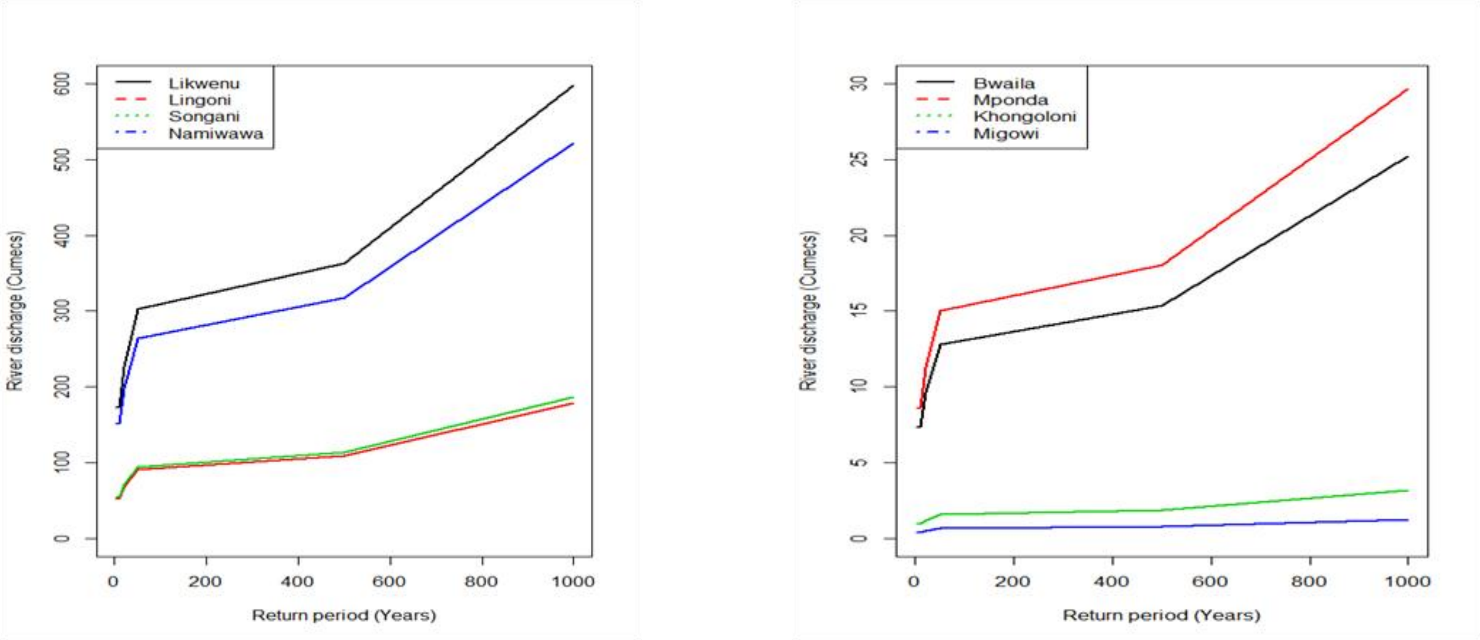

Figure 1. Estimated at-site river discharge for ungauged rivers in the Lake Chilwa basin

In addition, high record floods such as those estimated for ungauged Likwenu (302.39 m^3s^{-1}) and Namiwawa (263.68 m^3s^{-1}) at 50 years return period could be disastrous to human life and infrastructure if preparations are not done in advance to manage the risks associated with such floods. The study revealed that an area may experience large or low flows while it does not experience high or low rainfall respectively. This could be attributed to other factors such as type of land use in the area.

Generally, rivers flowing within the Lake Chilwa basin reveal annual variability with maximum flows occurring in rainy season such as the month of February and declining rapidly thereafter. A notable characteristic about rivers flowing in the Lake Chilwa basin is that they are perennial in their upper reaches but gradually lose their flow in the Chilwa – Phalombe plains due to the porous nature of the area. This suggests that flows recorded by some gauging stations such as those on Mulunguzi or Domasi rivers which are located very far from the lake do not give a clear indication about the amount of river flow that is actually discharged into the lake. It follows then that the Lake Chilwa level reacts sensitively to the amount of rainfall received from within its catchment area. These findings imply that floods and droughts will continue to take place in the Lake Chilwa basin even under climate change scenario.

Nonetheless, forests play a role in watershed conservation including storing excess rainfall through interception of run-off and increasing the infiltration of rain water, thereby recharging underground aquifers and serving as a source of stream flow. Land use and land use change which results in land degradation is a cause for concern because the net effect of the various feedback processes involved appears to be destabilization of ecosystems, making such lands prone to increasing flood risk and damage. In the Lake Chilwa basin the largest changes in terms of land area and arguably also in terms of hydrological impacts has arisen from on-going modest afforestation and significant deforestation activities which counter each other.

It is therefore important for livelihoods and for national economy to appreciate and prepare for the potential damage that may be caused by extreme weather events such as *El Niño* and others. It is evident that historical records for areas with consistent data have helped researchers predict the likely effects of each *El Nino* – Southern Oscillation (ENSO) in any given year. Many scientific institutions have devoted much time to study the ENSO and even conflicting data agree that ENSO may become the increasing norm in the future. Since some study has identified the Lake Chilwa catchment as high rainfall area, it is even more likely that rainfall seasons will come with extreme flooding events which may be destructive if not well prepared for. This is because the Lake Chilwa basin catchment area has undergone degradation in terms of forest cover overtime and in most cases land use has changed from forest to agricultural crops which influence river siltation and the amount of river discharge. In the absence of any floods recovery plan, it makes the transition from dry to wet season riddled with so many uncertainties and a cause for panic because floods bring with them so many disruptions which adversely affect disaster response thereby frustrating any intended recovery efforts.

Our Mission

To conduct operational forestry research to generate usable technologies and provide information for sustainable management, conservation and utilization of forests/trees and allied natural resources in order to contribute to improving the welfare of the people of Malawi.

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Mask Up and Get Vaccinated

COVID 19 is still here ……..Please protect yourselves and others