A Concept of Optimum Forest Area for the Sustainable Development of Nepal

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Abstract

Forest sector was badly suffered due to anthropogenic activities in the last two centuries before it is getting revitalized due to serious conservation efforts particularly after the Earth Summit in 1992. In order to expedite the development efforts by being considerate to the environment of the planet we live, United Nations has adopted seventeen sustainable development goals (SDGs) to be achieved by 2030. Sustainable development aims for harmony among physical, social and environmental development, and hence, guides for finding a balanced approach of development and conservation. This paper highlights the need for finding a balance between infrastructure development and forest conservation initiatives in Nepal with a focus of attaining SDGs by 2030. The economic status of Nepal is reviewed along with the plans, policies and trends of forest conservation. It highlights the need for a system perspective in which forest conservation is a component of the overall objective of sustainable development. A theoretical framework of optimum forest area for Nepal is presented by considering the contributions and obstacles of the forest sector towards attaining SDGs. Rather than focusing on complicated mathematical models, this paper presents a simple and practical concept of gauging the attainment of SDGs by a single index that may be useful to planners. The optimum forest area for Nepal has not been assessed and will be a scope of future studies. Once the idea of optimum forest area is adopted, major breakthroughs can be expected towards attaining SDGs in Nepal.

Keywords: *Conservation; Infrastructure development; Optimum forest area; Planning; Sustainable development goals*

Introduction

Forests covered four-fifths of the earth's area at the beginning of the Eighteenth century; it decreased to 30% by the mid-Nineteenth century, and further decreased to 24.4% by 1990 (THC1/iwggf, 1994). While forests are influenced by climate, landform and soil composition, anthropogenic activities associated with economic development were the primary reasons for this alarming reduction in the global forest cover. Scenarios like this were the reasons behind the organization of the United Nations Conference on Environment and Development (UNCED) [also called the Earth Summit]. The 1992 Earth Summit held in Rio de Janeiro, Brazil proposed an action plan called Agenda 21, which later became the basis of the seventeen sustainable development goals (SDGs) set for 2030. Agenda 21 highlighted the necessity for all countries to develop harmonized approaches in the management, conservation and sustainable development of global forests to meet the socio-economic and environmental needs of the present and future generations.

United Nations adopted the seventeen goals for sustainable development as shown in Figure 1. The SDGs consist of 17 goals, 169 targets and 230 indicators. SDG #15 is about the protection, restoration and promotion of sustainable use of terrestrial ecosystems and sustainable management of forests. SDG #13 suggests taking urgent action to combat climate change and its impacts. It aims to halve the base year's CO_2 emission level. Forests are effective to absorb CO_2 and hence, this goal also implies for the conservation of forests. In the post-Earth Summit era, forest cover has gained public attention and improvements are observed in many parts of the world. From the depleted forest area of 24.4% in 1990, the forest area has increased to 31% as of 2020 (FAO, 2020). Nevertheless, conservation of forests and gain in forest cover are quite challenging.

Figure 1: SDGs adopted by the United Nations (source: undp.org)

Forest conservation has been an important agenda in Nepal since long. Strict regulations were implemented and the conservation efforts in Nepal have become quite effective lately with forest area being increased to 44.74% (MFSC, 2017). However, the regulations are regarded as challenges by the people working for development. Project managers of many construction projects often blame that forest clearance is one of the most critical factors for the delay of the projects. Irrespective of the scale of deforestation and urgency of the project, every project has to get an approval from the Nepal government cabinet for cutting even a single tree. The process is quite lengthy and goes for years. For instance, Dang section of the Postal road project, which is a national pride project, was waiting for the forest clearance for at least three years (based on a discussion with the project authority). It is widely realized that rules are not only harsh but also irrelevant in many aspects.

As a counter-productive outcome of the harsh and lengthy legal procedures, projects are sometimes heard of encouraging illegitimate practices for opening tracks and clearing construction sites, particularly in projects undertaken by the local governments. This reaction to over-regulation must be stopped and it will be possible by properly addressing the development needs and public aspirations. The aspect of forest conservation should acknowledge other goals of sustainable development too, particularly in the challenging circumstances of attaining the SDGs by 2030.

Apart from the goals focused on forest conservation, SDGs also emphasize the building of resilient infrastructure and promotion of inclusive and sustainable industrialization (SDG #9). SDG #8 emphasizes to promote economic growth and productive employment. Economic growth, infrastructure construction and industrialization require cutting of trees at certain places. Infrastructure such as roads, airports, and urban facilities often require large scale tree cutting in the project areas. SDG #10 asks to reduce inequality within and among countries. This suggests that many of the benefits and opportunities available in the developed countries should also be made available in the developing countries. Despite conscious efforts on conservation, the transformation of countries from the "developing" to "developed" stage will incur not only the monetary cost but also the environmental cost.

SDG #7 is about ensuring access to affordable, reliable, sustainable and modern energy for all. The world is moving from the fossil fuel sources of energy towards renewable energy sources including hydropower, solar and wind energies. Construction of such energy facilities will also require some deforestation in the construction areas. Even to ensure the availability of water and sanitation for all as stipulated in SDG #6, reservoirs, tanks, large treatment facilities, and extensive pipe networks should be constructed. Often, the source of water is within or besides forest areas, and hence, these structures also warrant for cutting of trees in the construction areas.

Goals such as ending poverty (SDG #1), ending hunger (SDG #2), ensuring healthy lives (SDG #3) and ensuring quality education (SDG #4) also involve many construction and land development activities. Forests cannot remain untouched except for the protected areas. Moreover, Nepal has a forest cover of 44.74% with many people having their livelihood connected to forests, and hence for Nepal, SDGs #8, 12 and 15 infer that forest resources should be sustainably utilized for achieving economic growth and prosperity.

Forest cover is basically a function of cover loss and cover gain. Conservation aims to increase cover gain while development activities including infrastructure construction, settlement and expansion of agricultural land have caused loss in forest cover, particularly in Terai and urban region. Similarly, utilizing forest resources for economic development may result in the loss of cover unless forests are sustainably managed. Therefore, forest conservation and development needs are often seen as two conflicting agendas. However, both are essential and hence should be promoted in harmony. The crux of the problem lies in treating the two agendas separately, and accordingly, the solution lies in striking a balance between the two agendas as a system perspective. The system perspective will not only account for the loss and gain in forest cover but will also assess the need of development activities by acknowledging the importance of conservation, and thus, determine optimum forest area for the sustainable development of Nepal. As a planning perspective, this paper analyzes the role of forestry sector towards achieving SDGs and outlines a theoretical framework in introducing the concept of optimum forest area for Nepal.

Economic status of Nepal and the challenge of achieving SDGs

The United Nations Committee for Development Policy during its triennial review in February 2021 recommended for Nepal's graduation from the Least Developed Country status, thus, paving way for Nepal to be transformed into a developing country by 2026. Out of the three indices decisive for the question of graduation, namely, Gross National Income (GNI) per capita, Human Assets Index, and Economic and Environmental Vulnerability Index, Nepal met the thresholds for the latter two, thus being eligible for graduation (PMUN, 2021). While the threshold for the GNI per capita was set at USD 1222 for the triennial review, Nepal's GNI was USD 1090 as of 2019. Nepal is a lower middle income country and has envisioned to achieve the middle income country status by 2030 AD. The SDG roadmap of Nepal (NPC, 2016) has set a target of per capita GNI of USD 2500 by 2030. Similarly, Nepal's GNI per capita should exceed USD 4046 in order to achieve the status of a middle income country. This means the national income should be increased by approximately four times in 10 years. Nepal needs to achieve an unprecedented high rate of sustained economic growth for several years in order to materialize the target of being transformed into a middle income country by 2030.

Furthermore, as a member of the United Nations, Nepal is destined to achieve SDGs by 2030. National Planning Commission of Nepal has estimated the budget requirement for attaining the SDGs. The average annual budget requirement is estimated at approximately USD 20 billion (NPR 2025 billion). As per the predictions based on currently available resources, yearly deficit of USD 5.8 billion is estimated (NPC, 2017). This warrants for exploring all possible resources including natural resources in Nepal that were mostly underutilized in the past but have prospects of being significantly utilized. Such resources include not only the conventionally acknowledged sectors of agriculture, tourism and hydropower but also the yet to be properly acknowledged sectors of natural construction materials and forests. On the supply side, Nepal is bestowed with abundance of these two latter resources and on the demand side these sectors have a promising market in Nepal and neighboring countries. Preliminary analysis of the supply and demand sides at the Province Planning Commission of Lumbini Province (e.g., Gautam et al., 2020) indicates that these sectors have potential of attaining growth of at least one order of magnitude in the respective sectors by 2030.

While assurance of resources is a challenge, improvement in the ability of the country for capital expenditure has become equally challenging. The capital expenditure of Nepal government has been

consistently poor with expenditure as low as 50% of the budget. A plethora of factors affect the ability to execute the budget including political system; governance; policies and acts; and availability and capability of human resources. Among the policy and act related issues, forest clearance has been a major obstacle for the commencement and timely execution of nationally important infrastructure projects. Delay in project execution will jeopardize the attainment of SDGs, and hence, all obstacles should be critically reviewed to expedite the execution of development projects. Attaining all SDGs should be prioritized over attaining a few SDGs (e.g., #15 and 13), and a holistic approach will be essential.

Analysis of forest scenario in Nepal from planning perspective

Global perspective

The global forest area in 2020 was estimated at 4.06 billion ha, which is 31 percent of the total land area (FAO, 2020). Approximately 50% of the global forest area lies in only four countries including Russia (20%), Brazil (12%), Canada (9%) and USA (8%) and approximately two-thirds of the global forest area lies in ten countries. Eight countries have no forests and another fifty countries have forest area less than 10%. Seven countries have forest area greater than 90% (FAO, 2020). Forest area of Nepal is 6.6 million hectares and occupies 44.74% of the land area of Nepal (MFSC, 2017). Forest area of Nepal is 0.16% of the global forest area. Comparison of Nepal's forest to the global forest reveals two aspects: first, percentage forest area of Nepal is well above the percentage forest area of the world, and second, Nepal's forest being negligibly small for the globe, Nepal should aim to address its own needs of sustainable development before aiming to influence the global environment. This overall outlook will be essential to accurately resolve the often conflicting perspectives of forest conservation and infrastructure development.

Role of forests to the economy and development of Nepal

Gross domestic product (GDP) of Nepal and its composition for each fiscal year is estimated by the Bureau of Statistics, Nepal. The contribution of forestry is jointly reported with that of agriculture. For fiscal year 2019/20, contribution of the agriculture and forestry sectors to the national GDP was estimated at 27.08% (MoF, 2020). Even though exact breakdown of forestry sector is not available, agriculture is the predominant sector and the forestry sector has a small contribution to the national economy despite the large forest area of 44.74%.

The Fifteenth Plan of Nepal has set a target of maintaining the existing forest cover area of 44.74% by 2024. It aims to sustainably produce 0.85 million m^3 of wood per year. Based on the current market rate of approximately USD 350 per m^3, this amount of wood may hardly contribute 1% of the GDP of Nepal. Apart from timber, forests contribute through herbs, fruits, firewood and tourism. However, the contribution of forests to the national economy has not been estimated in the Plan. It rather states that mobilization of forestry sector is a major challenge. The Plan estimates the combined percentage contribution of the agriculture, and forestry sector to the national economy to shrink from 27% to 22.3% of the national GDP in 5 years' duration ending in 2024 (even though it will grow in terms of absolute value). Three major drawbacks can be associated to the Plan document. First, the target of 44.74% forest area was set to be identical to the existing forest coverage of 44.74% and does not have any rational basis associated with development or economy. Second, except for the incremental growth in the production of forest resources, the document has not set a major departure to utilize forest resources so as to achieve the sustained high economic growth rate anticipated by 2030. It is worthwhile to mention that, owing to the harsh and short-sighted regulations, Nepal imported at least 0.83 million m^3 of timber from Asian, African and Australian countries in 2015 but wasted 1 million m^3 of timber to decaying during the same period (MFSC, 2017). The third drawback of the plan document is that it does not recognize the obstacles created by forest sector to the infrastructure development, and hence, fails to address on how to remove such obstacles.

Ministry responsible for forests has been implementing a Forest Investment Program since 2017 (MFSC, 2017). The program outlines nine major drivers of deforestation and forest degradation in Nepal as: (i) unsustainable harvesting and illegal harvesting; (ii) forest fire; (iii) infrastructure development; (iv) overgrazing; (v) weak forest management practices; (vi) urbanization and resettlement; (vii) encroachment; (viii) mining/excavation; and (ix) expansion of invasive species. Low priority on research and development is identified as one of the causes of deforestation and forest degradation. Moreover, lack of effective land-use planning systems (at all levels) is identified as a challenge that hinders the decision-making processes and fails to address cross-sectoral conflicts regarding forest land use and allocation, particularly for infrastructure development. While national plan and policy documents do not address the cross-sectoral conflicts regarding forest conservation and infrastructure development, the Investment Program acknowledges the need of addressing this aspect. However, none of its five action plans considers reducing such conflict.

Trend of forest cover

While Nepal encountered mean annual loss of forest of 0.47% during 1978-1994 and 0.53% during 1990-2000, this negative trend was reversed with an annual increase in forest cover of about 0.8% from 2000-2010 (MFSC, 2017). From the 40.3% forest area in 2015 (Sharma, 2017) to 44.74% in 2020, an average increase in forest area per year is 0.89%. Out of the forest cover area of 44.74%, approximately 23% of Nepal's land area has been designated under protected areas including national parks, reserves, conservation areas and buffer-zones (MFSC, 2017). Many villages in hilly areas have witnessed a declining population. With a declining population and also with the changes in their lifestyles (reduced use of firewood and less demand of fodder for cattle), many agricultural plots in those villages have now been converted into jungles. More than 20% of agricultural land is abandoned or unutilized in hilly districts (MFSC, 2017) and this must have contributed partly to the recent gain in forest cover in Nepal. This trend can be expected to continue in the coming years.

The gain in forest cover has lately brought some negative consequences, particularly, human-wildlife conflicts. Public consultations and focus group discussions during preparation of the first periodic plan of Lumbini province (PPC, 2019) revealed that monkey population has significantly increased due to increased tree cover and has been a major driver for forced emigration from hills to Terai region. Banke and Bardiya national parks are situated in Lumbini province and people in Bardiya district suffer a lot from wild lives including tigers and elephants. Ten people were killed by tigers in Bardiya district during 2020 April to 2021 March (Adhikari, 2021). This is an alarming situation and should be solved in a systematic way. A senior conservationist authority in Nepal government suggests that Nepal should urgently implement a policy for defining the maximum threshold population of a particular type of animal considering the availability of resources (Acharya, 2021). While forest conservation contributes positively to bio-diversity, it may be reasonable to think of conservation in an optimum way that maximizes the merits of conservation without escalating human-wildlife conflicts.

Forest policy and conflict with infrastructure development

Nepal government implemented a forest policy in 2014 (MFSC, 2014). The policy states to maintain the forest area of Nepal to at least 40% and this target resembles to the forest area that existed in Nepal during 2014. It appears that a rational basis was not followed to choose this target. This is further illustrated by the fact that the Fifteenth Plan set a target of 44.74% because the forest area in Nepal during preparing the plan was 44.74% (NPC, 2020). Nepal cannot afford to set an ever increasing target as the forest area keeps on increasing. Therefore, Nepal needs to think of an optimum forest area for maximizing the attainment of SDGs.

The latest forest act of Nepal came into effect in 2019 (MoFE, 2019). However, the act was drafted on the philosophy of maximizing the forest area and not on optimizing it. Any infrastructure project, irrespective of its size, should get a permission from the Nepal government when it needs to be constructed within forest boundary and that applies equally for all types of lands within the national

forest territory. In order to proceed for the permission, the project should be demonstrated as a nationally important project. Even with that, an equal area should be provided somewhere for compensation forestry. Sub-national governments should also apply for permission from the national government even to cut a single tree. Moreover, the application for the permission should be filed on case by case basis for individual projects with duly performed environmental studies. The duration from the date of application to the date of approval is indefinite and may go for years.

Even if legal procedure is lengthy, development projects should comply with the legal requirements. However, not all the projects comply with the environmental regulations. A road in Dhangadhi was blacktopped without removing approximately 200 Sal trees as shown in Figure 2. A similar story repeated in Chitwan with 50 trees in between the road pavement (Pokhrel, 2020). While these are mostly the cases of legal non-compliance, they illustrate a form of prevailing conflict between forest conservation and infrastructure development. Two approaches will be required to prevent such misdeeds in the future. From the perspective of implementation, legal compliances should be strictly enforced, and from the perspective of planning, complicated and lengthy procedure in granting forest approval should be simplified and expedited.

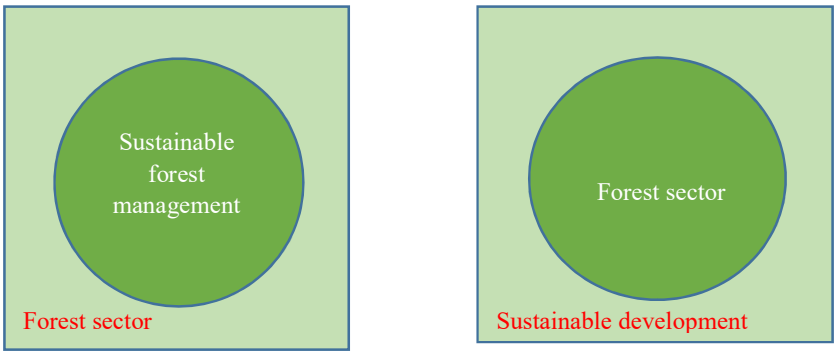
The implementation of the forest act is based on qualitative grounds, and hence, the scale or extent is not a focus. For instance, the total forest land handed over to infrastructure projects during 10 years from 2006/7 to 2015/16 was 2137 hectares with a yearly average of 213.7 hectares (Sharma, 2017). The forest land handed over for infrastructure projects during a decade accounts for 0.0145% of the total land area of Nepal. At this rate of deforestation, it will take approximately 690 years for the forest area to deplete by 1%. For the forest area to deplete from 44.74% to 44%, this rate will take more than 500 years. Moreover, the Forest Investment Program aims to rehabilitate 10000 hectare of degraded forest in 8 years with an average of 1250 hectares per year (MFSC, 2017). The planned 1250 hectares per year of conservation is 5.8 times the 213 hectares per year of forest area handed over to infrastructure construction. This data and the encouraging forest cover growth rate of 0.89% in recent years illustrate that Nepal is witnessing net forest gain in recent years despite small loss caused by infrastructure development. Estimation of optimum forest area for Nepal could provide confidence and a means to simplify the process of handing over the forest land for infrastructure development aimed at achieving SDGs.

Figure 2: Road blacktopped in Dhangadhi without removing trees from the pavement (Bist, 2020)

Optimum forest area for sustainable development

System perspective

Forest is a cross-cutting sector related to environment, bio-diversity, landslide prevention, infrastructure development, land planning, timber, herbs, livelihood, employment and many others. Therefore, forest is a crucial aspect of national planning with dimensions of environment, economy, physical development and social development. However, most forest-related studies inadequately analyze these multiple sectors, particularly infrastructure development and land planning perspectives. Even when they are considered, the issues are often regarded as conflicting issues and not on a holistic approach. This study proposes to consider forest sector as one of the components of a system of planning and development. Lately, the concept of sustainable forest management is regarded as an effective approach of forest management. Even though it has been effective for the management of forest resources, the approach is still inadequate from the system perspective as conceptually illustrated in Figure 3. Since forest sector has served as an obstacle for the rapid infrastructure development aimed at attaining SDGs, management of forests should be regarded within the framework of achieving SDGs. As a cross-cutting sector, planning and management of forests should be an area of interest for researchers involved not only in forestry sector but also in economics, physical infrastructure and social development.



a. Existing approach b. Proposed approach

Figure 3: Forest management from sustainable development perspective

Single index of SDGs

The overall concept of sustainable development would arrive at the integration of 230 global indicators, 169 targets and 17 goals. Moreover, Nepal has added 249 local indicators, thus increasing the number of indicators to 479. Despite thoughtful assessment by many experts around the globe, measurability and practicality of these goals, targets and indicators pose challenges to researchers (Hansson et al., 2019; Li et al., 2020). The link between a single indicator and the overarching SDG may be difficult to establish (Hansson et al., 2019). This is true mostly because SDGs cover the wide and multifaceted dimensions of development and numerous indicators were actually proposed to gauge these dimensions. Even though indicators for the SDGs were proposed to measure the complex idea of development in simpler terms, the indicators are not easy to be expressed into a set of mathematical functions. Several indicators were not relevant as standalone indicators and some indicators may have unintended negative consequences when viewed in isolation (Hansson et al., 2019). Hence, despite a plethora of studies, the idea of sustainable development still remains a complex topic for academic research.

While researchers globally have faced difficulty in monitoring and interpreting the indicators, additional indicators have made it extremely complicated to monitor and govern the progress of SDGs in Nepal.

From the planning perspective, one should be able to compare SDG status reports from different years. Even if a single value indicator may be questionable from the viewpoint of mathematics, a practical approach from a planner's experience in arriving at a single value is proposed as below.

A country is assumed to have achieved SDGs if all the targets are achieved by 2030. For the target that shows reasonable possibility to be achieved by 2030, the probability of the given indicator is treated as 1 (or 100%). As countries aim to achieve SDGs by 2030, the probability should theoretically be 100%. However, rather than assuming the probability as always 100%, year-wise improvement in the level of probability can be a useful strategy. Accordingly, a country may have the probability of achieving the targets of, say, 70% during year 2021 and it may increase to 100% by 2030. For instance, Nepal has set the GNI per capita of USD 2500 by 2030 but, say, the probable value of GNI by 2030 appears to be USD 2000 as of 2021's analysis. Then, the probability for this indicator is 80% in 2021. In order to increase this probability in 2022, new avenues should be explored to increase the rate of growth in income. Easing the permission of forest land for infrastructure development or increasing the utilization of forest resources may increase the probability and hence a policy action in that direction in 2022 may increase the probability of attainment of GNI target to, say, 85%. This is how the probability for a particular indicator can be estimated. Probabilities of all indicators for a given target can be estimated and an average probability for that particular target can be obtained. Furthermore, probabilities of all targets can be averaged to estimate the probability of the given goal and accordingly, probabilities of all goals can be averaged to estimate the probability of all SDGs. The limitation of the mean value should however be acknowledged as the average of 0.5 and 0.5 is 0.5 and that of 1 and 0 is also 0.5. Nevertheless, the ultimate goal is 100% and when targets are closer to 100%, this limitation becomes feeble. Hence, this simple approach is expected to serve as a planning strategy by yielding a single index for the seemingly complex and diverse SDGs.

Optimum forest area

The SDG status and roadmap document of Nepal has included the forest area of 44.7% as the baseline information for indicator 15.1.1 and does not set any increment or decrease in this value by 2030 (NPC, 2016). It is understood that Nepal needs to strike a balance between forest conservation and physical development. Therefore, studies should be conducted to determine the optimum forest area for Nepal from the perspective of attaining SDGs.

From the standalone perspective of forest conservation, attempts are made to maximize the forest area. However, efforts of forest conservation (attaining SDGs #15 and 13) should not hinder the efforts to attain remaining SDGs, such as SDGs #1, 7, 8 and 9. Therefore, forest coverage area for a particular region or nation could be regarded from the perspective of an optimum content. When the forest coverage area is too low, forests cannot impart the precious environmental benefits of acting as the sink for greenhouse gases, promoting bio-diversity, maintaining hydrological cycles, and so on. On the other hand, when the forest coverage area is too high, inadequate land is available for infrastructure and settlement development. Human life is endangered of wild animals. Evapotranspiration can be excessive (Barkey & Nursaputra, 2019). Moreover, when use of forest resources is prohibited in a nation despite having a relatively high forest area, human needs of forest-based resources are fulfilled by imports. This will negatively contribute to the national economy and promote poverty, thus opposing the attainment of SDG #1. Between the two extremes, an optimum forest content will provide environmental benefits, will supply forest resources and will not restrict for essential development activities aimed at attaining sustainable development.

Figure 4 presents a schematic graph to illustrate the optimum forest area concept. This paper outlines only a theoretical framework, and hence, indicative functions are presented. In order to illustrate the concept, four lines are plotted in a single graph. Percentage forest area is chosen for the x-axis and double y-axes are chosen for the dependent variables. For lines of Type 1 to Type 3, the y-axis on the left side represents an output function that can be measured in terms of a specific indicator or target.

For the fourth line (overall), the y-axis on the right side represents the single index of SDGs as defined in Section 0. Ideally, the peak of the overall line should be 100% but forest is only one of the many variables contributing to the attainment of SDGs, and thus, the optimization function of forest will have the peak lower than 100%.

Some indicators of SDGs may be independent of the forest cover area and such indicators are represented by the line of Type 1 in Figure 4. Some indicators may increase with an increase in forest area and can be represented as Type 2. On the contrary, some indicators may decrease with an increase in forest area and they can be represented as Type 3. Type 2 and Type 3 are idealized here as linear functions but in reality they may be nonlinear with second or higher degree polynomials. Some output functions may already show an optimal relationship with the increase in forest area. For instance, considering watershed management as the output function, Barkey & Nursaputra (2019) determined the optimal forest area for Maros watershed in Indonesia. The study indicated that an increase in forest area causes the surface runoff to decrease and hence the supply of ground water to increase. However, this becomes valid up to an optimal forest area beyond which the evapotranspiration component becomes increasingly larger and hence the supply of ground water begins to decrease. For the Maros watershed, forest area of 33.74% was shown to be optimum for balancing the supply of ground water and evapotranspiration (Barkey & Nursaputra, 2019).

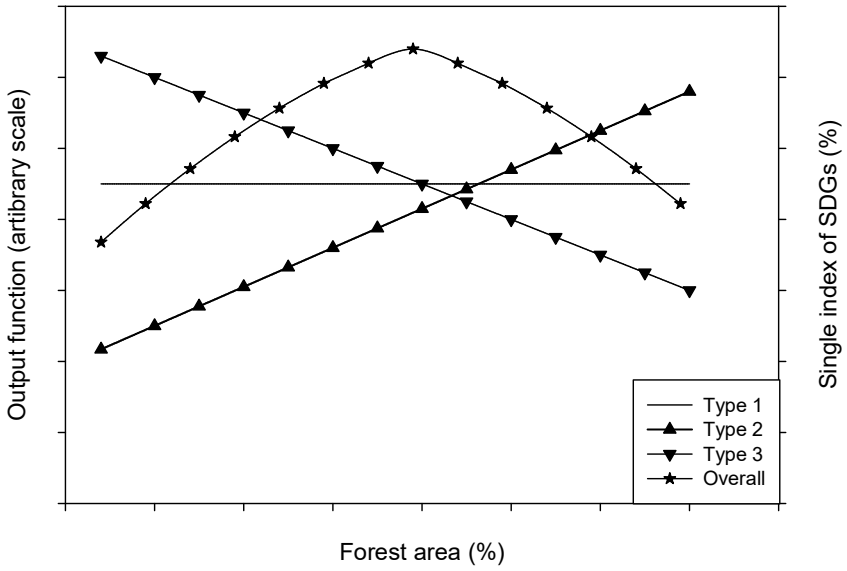


Figure 4: Schematic optimization function of forest area for sustainable development

It is believed that the proposed theoretical framework serves as a system perspective to estimate the optimum forest area to maximize the sustainable development of Nepal. For this simplified and practical model, it will be unlikely to obtain a clear mathematical function for the output variables but a plot of at least three points may give an idea of the output function. The current status of the desired output function and the existing forest area can be taken as a reference point and successive points can be generated by assuming an increase or decrease in forest area by some percentage points.

Output variables of environmental benefits such as conservation, bio-diversity, carbon trading and global warming can be evaluated as a function of forest area. Similarly, output variables such as economic benefits from forest resources, expedition in infrastructure construction due to ease of forest clearance (SDG #8 and 9), reduction in poverty (SDG #1) can also be estimated for different forest areas. To a certain extent, utilization of renewable forest resources may actually discourage the import and use of non-environment friendly products such as aluminum and plastics, thus, serving more to the

environment than from the mere conservation of forests. For this particular case, the y-axis (left) of Figure 4 may plot CO_2 emission from the additional aluminum products imported to substitute the demand of timber products that could not be materialized due to forest conservation. The framework of Figure 4 can be applicable even for the imported timber because 1 m^3 of imported timber for Nepal will be the sum of a) loss of forest somewhere in the world to produce 1 m^3 of timber, and b) extra energy and resources consumed to transport the timber to Nepal. The framework of Figure 4 can also be utilized for human-wildlife conflict.

Concluding remarks

With the aim to facilitate the attainment of sustainable development goals (SDGs) by 2030, this paper discussed about forests from a planning perspective. By reviewing the economic status of Nepal and its journey towards SDGs, the role of forests to the national economy and development were discussed. This paper analyzed the forest cover area in Nepal and reviewed plans and policies regarding forest conservation and management. It highlighted the often conflicting idea of forest conservation versus infrastructure development. While standalone perspectives on these two sectors have led to conflicts, a system perspective was deemed essential to strike a balance between these two aspects and to achieve SDGs. A conceptual model was proposed to regard forest management from sustainable development perspective. As a cross-cutting sector, planning and management of forests should be an area of interest for researchers involved not only in forestry sector but also in economics, physical infrastructure and social development.

Once forest is regarded as a component of a system of sustainable development, this paper proposed a theoretical framework for the optimum forest area for Nepal. The model stresses that forest conservation should focus on both positive and negative sides of the conservation efforts Nepal has been practicing and the conservation should aim not for maximizing the forest area but for optimizing it. Forest conservation should be analyzed in relation to the attainment of not only SDG #15 and 13 but also the SDGs in overall. Accordingly, this paper presented a simple and practical concept of gauging the attainment of SDGs by a single index that may be useful for planners.

Developing countries have an opportunity to realize sustainable development by learning from developed countries' experience. Since forest conservation is largely regarded as a "do not touch" approach in Nepal, the fear of touching the forest resources will be reduced when optimum forest cover area is determined. By adopting the idea of optimum forest area, two major breakthroughs can be expected in the forest management sector in Nepal. First, the obstacles created by the forest policies in constructing infrastructures vital for achieving SDGs can be removed, and second, the negligibly small contribution of the underutilized forest resources to the GNI of Nepal can be scaled up by manifolds.

The objective of this paper was to establish the concept of optimum forest area for sustainable development. The optimum forest area was not assessed in this paper and will require further research.

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