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Main Principles and Methods of Identification of High Conservation Value Forests in the Conditions of Mountainous Relief: Case of Armenia

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Abstract: Armenia is a small mountainous country with remarkable biodiversity. The forest cover of Armenia makes up 11.17% of the total territory of Armenia. The forests of Armenia make important habitat for numerous biological objects. They also provide important ecosystem services, including key services to forest adjacent population. Deforestation and forest degradation are serious threats in Armenia. In the result of special studies the principles and criteria for identification of HCVFs (high conservation value forests) in the conditions of Armenia were developed. They are based on the guidelines for identification and management of HCVFs, but adapted to the conditions of mountainous forests of Armenia as a small country. Out of six generic types of HCVFs, it is suggested to define five types of HCVFs with respective sub-types. Proper protection of such forests shall ensure conservation of biological diversity and maintenance of ecosystem services provided by forests.

Key words: HCVFs (High conservation value forests), identification, criteria, thresholds, Armenia.

1. Introduction

Forest is habitat for numerous biological objects including human beings. Destruction of forests is a serious threat to ecosystems and people. Meanwhile rational use of forests can ensure harvesting of forest products without damaging biodiversity or reduction of forest reproduction capacities. It can also maintain the typical scale and character of ecosystem services provided by forests. Forest use with social benefits through long-term use of forest resources can bring material and social benefits to local communities and general public. At international level this is ensured through identification and protection of HCVFs (high conservation value forests) defined by the FSC (Forest Stewardship Council) [1]. The long-year experience has shown that in order to maintain the whole forest biodiversity and ecosystem services it is necessary that 20% of any forest area remains out of intensive use. Respectively, the HCVFs shall represent the mentioned proportion in any forest area. The FSC encourages us to apply special management aimed at protection and improvement of the natural state of HCVFs anywhere.

2. Background

RA (The Republic of Armenia) is a South Caucasian republic bordering with Georgia, Azerbaijan, Turkey, and Iran. It is a landlocked country with a total area of 29,740 km^2. Phytogeographically, Armenia is located at the junction of two floristic provinces—Caucasian and Armeno-Iranian [2]. Their peculiarities and vertical zonation have resulted in great variety of vascular flora and vegetation. About 3,800 vascular plant species and all main ecosystems of the Caucasus (excluding vegetation of humid subtropics) are represented in Armenia [3]. The diversity of landscapes, natural and geological peculiarities, rich geological history, a wide range of climatic zones and impact of various anthropogenic

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factors have resulted in formation of a wide diversity of forest communities [4-8].

According to the remote sensing data from 2011, the forest cover of Armenia makes up 332.333 thousand ha or 11.17% of the total territory of Armenia. The forests in Armenia are distributed very unevenly. In total, 62.5% (207,000 ha) of forests is located in north-eastern regions of Armenia, 13.5% (45,000 ha)—in central regions, 2.4% (8,000 ha)—in southern and 21.6% (72,000 ha)—in south-eastern regions of Armenia. Main forest species include oak (*Quercus iberica* Stev. and *Q. macranthera* Fisch. and C. A. Mey. ex Hohen.), beech (*Fagus orientalis* Lipsky), common hornbeam (*Carpinus betulus* L.) and pine (*Pinus kochiana* Klotzsch. ex K. Koch). The open forests are mainly represented by juniper open woodlands (*Juniperus* spp.).

Beech forests (*F. orientalis*) occur only in northern Armenia at the altitudes of 800-2,000 m above sea level mainly on northern slopes. Oak forests have complex and diverse structure. They occur in the northern, southern and central regions of Armenia at the altitudes of 600-2,200 m. Depending on the altitude three species of oak dominate: up to 1,400-1,500 m—Georgian oak (*Quercus iberica*), above that—Caucasian oak *(Q.* macranthera) and in Southern Armenia in the most dry conditions up to 1,000 (1,100 m)—Araks' oak *(Q. araxina* (Trautv.) Grossh.).

Forest ecosystems provide a variety of services and goods. However, the current anthropogenic pressure on forest ecosystems results in reduction of forest areas, changes in forest species composition and forest structure, reduces capacities of natural regeneration and productivity of forests.

The main cause of forest degradation is non-regulated logging. Existing socio-economic problems and high demand for wood still keep the rate of loggings higher than the rate of natural forest regeneration. Fuel wood is still the main source of fuel for the forest adjacent population. Another cause of forest degradation is livestock grazing in forest areas subject to regeneration, especially in community adjacent territories. It results in almost zero natural seed regeneration of forests.

In addition to anthropogenic impact, during the recent decades the climate change has become another important threat to forest ecosystems. According to the Second and Third National Communications on climate change of RA [4, 9] the lower timberline will shift 250-300 m up due to the climate change and bring significant changes in the structure of forest ecosystems. Without adaptation measures by 2030 the forest losses may reach 14-17.5 thousand ha.

Increased forest fires and mass outbreaks of forest pests (especially those feeding on leaves) also cause significant damage to forest ecosystems.

Given the limited forest cover of Armenia deforestation is a real threat. It has very negative consequences on environment and causes significant losses of income through reduction of ecosystem services. The processes of land-slide and erosion have been increased along with expansion of wind-fallen or snow-fallen areas. The upper fertile layer of soil is being lost, meanwhile its regeneration in mountainous conditions is an extremely lengthy process. It resulted in drying or reduction of water in natural springs, rivers and streams with consequently significant damage to communities and agricultural lands.

3. Materials and Methods

The materials for this study included literature on HCVFs (guidelines, studies on applying international classification of HCVFs in countries, etc.), materials and studies on forests of Armenia, their values such as biodiversity, habitats, endangered species, etc. and status (research papers, national reports, etc.). The desk study included the analysis of generic classification, its application to different conditions and the analysis of the status of forests and forest values in Armenia. The conclusions derived from the above analytical reviews were used to suggest

classification of HCVFs in Armenia with the thresholds for their identification.

4. Results

The guidelines on identification and management of HCVFs [10] suggest identification of six types of HCVFs. Considering international classification of HCVFs and available literature on its application in different countries/regions [11-17] as well as the characteristics of forests in Armenia and their status the following principles and classification are suggested for identification of HCVFs in Armenia including the types (sub-types) of HCVFs and thresholds for their identification.

4.1 Type HCVF 1. Forest Areas with Globally, Regionally or Nationally Significant Concentrations of Biodiversity Values

Armenia is a country with extremely rich biodiversity. According to the Fifth National Report to the Convention on Biological Diversity of the RA [3] in Armenia there are about 3,800 species of vascular plants, 549 species of vertebrates and about 17,200 species of invertebrates. Out of them 452 species of plants and 308 species of vertebrates and invertebrates are registered in the RB (Red Book) of Armenia [18, 19]. They are of national value. There are numerous endemic species: about 500 species of fauna (about 3% of the fauna) and 144 species of flora (3.8% of total flora). There are also endemics of the Caucasus, which are of global value. Some of these species are included in the IUCN Red List of threatened species. Rare ecosystems, which occur only on the territory of Armenia are also of global value. Meanwhile, they are not always located within the boundaries of SPNA (specially protected nature area) of Armenia. We consider all the above mentioned species and ecosystems decisive for identification of type 1 of HCVFs.

4.1.1 HCVF 1.1 Specially Protected Nature Areas

General provisions: Based on the peculiarities of the country, the category of concerned SPNA and the state of forests and biological diversity in the given SPNA, the whole territory of the SPNA or a part of its forest area can be defined as HCVF 1.1. The whole territory of the SPNA can become an HCVF 1.1 area if it has strong conservation regime according to the IUCN classification of protected areas (namely, reserves) or it is an SPNA with lower status of conservation, but it has exceptional significance for biodiversity conservation. In the second case only some forest landscapes within the SPNA can be defined as HCVFs given they comply with the characteristics of sub-type HCVF 1.1.

In Armenia there are four categories of SPNAs (state reserves, national parks, state sanctuaries and natural monuments), which correspond to the IUCN I-IV categories of protected areas [20]. The majority of SPNAs of Armenia have forest ecosystems, which by their status can correspond to sub-type HCVF 1.1. At the moment of their establishment, respective forest ecosystems had different status (intact or somehow affected) and over years they have been under different conservation regimes. Therefore, only part of forests in the SPNAs of Armenia has potential to be defined as HCVF 1.1. This is especially valid for NPs (national parks) and sanctuaries, as not all forest areas in the mentioned categories of SPNAs can be considered the areas having globally, regionally or nationally significant concentration of biodiversity values.

Given the above-mentioned and the current state of SPNAs, we consider that forests of two reserves—Khosrov Forest and Shikahogh State Reserves, which correspond to category I by IUCN classification, can be defined as sub-type HCVF 1.1.

According to the RA Law on SPNAs [21] the NPs of Armenia, which correspond to category II by IUCN classification, are subject to zonation. The reserve zones of the NPs are characterized by presence of globally, regionally or nationally significant biodiversity and have strict protection regime. The

mentioned zones of Dilijan, Sevan and Arevik NPs can also be identified as sub-type HCVF 1.1. In order to verify the presence of HCVs (high conservation values) in the forests of the other zones of the NPs, it is necessary to carry out comprehensive assessments to identify their actual ecological and social values.

The forests of natural monuments and sanctuaries, which correspond to categories III and IV of IUCN classification, shall be subject to comprehensive assessment as any other forest area. If the assessment reveals the presence of HCVs, then the areas can be defined as HCVF under type 1 (sub-type 1.1) or any other type (sub-type).

4.1.2 Sub-type HCVF 1.2 Forest Areas with Concentration of Threatened and Endangered Species and Sub-type HCVF 1.3 Forest Areas with Concentration of Endemic Species

General provisions: The forest areas belonging to sub-types HCVF 1.2 and 1.3 are characterized by the presence of rare, threatened and endangered as well as endemic species of flora and fauna. Such areas are usually identified by specialists-experts. In many cases these are characterized as "biodiversity hotspots", important bird areas, important plant areas or others.

The RB of Armenia [18, 19] has information on the rare, threatened and endemic species of plants and animals of Armenia. The RB of plants includes 452 species of vascular plants and 40 species of fungi and the RB of animals includes 308 species (155 species of invertebrates and 153 species of vertebrates). All the species registered in the RB have been assessed by IUCN criteria.

Given the above-mentioned and considering that the RB listed species under the categories CR and EN are under the biggest risk of extinction, it was considered expedient to focus only on the mentioned categories for identification of sub-type HCVF 1.2. The species under the categories CR and EN need urgent conservation and identification of their viable populations in forest ecosystems is a priority when deciding about HCV of forests.

Therefore, an area could have been assessed as HCVF (sub-type HCVF 1.2) if it has RB listed species of plants and animals under the categories CR and EN.

However, as the number of the mentioned species in the RB of Armenia is rather big (359 species of plants, 31 fungi, 112 invertebrates and 44 vertebrates) and the qualified human resources for identification of such species in the field are rather limited, it is suggested to focus on distinctive and more attractive species—flagship species, which can be easily identified even by non-specialists.

It is suggested that the flagship species include well-known large vertebrates, highly decorative species of plants and bushes, most valuable and rare tree species, distinctive and most characteristic invertebrate species as well as the species with very narrow areal (for example, there are only 1-2 populations of the species), but clear information on the habitat where they are located.

But even with this approach in practice all forest areas of Armenia are covered by the areals of flagship species and classifying them all as HCVFs would directly contradict the social and economic aspects of sustainable forest use. Therefore, based on the statistical analysis and analysis of available mapping material, it is suggested that the forest ecosystem is defined as HCVF 1.2 if there are totally at least 5 species of plants and animals or 3 flagship species belonging to the categories CR and EN as per the RB of Armenia. The forest areas with the presence of rare and endangered species with the number less than the minimal threshold can be defined as HCVFs only in exceptional cases when the given species has crucial value not only at national level, but also from global perspective, for example, included in the IUNC Red List as having high risk of extinction.

It is necessary to apply differentiated approach regarding definition of the minimal area necessary for conservation of populations or concentrations of

certain rare/flaghship species. With consideration of external ecological conditions of the given area as well as characteristics of the given species, the size of such areas can vary from 10 ha up to the boundaries of the whole forest ecosystem.

The level of endemism in vascular plants in Armenia is very high—144 species out of 3,800 of total number, making 3.8% [3, 22]. The majority of endemic plants of Armenia were registered in the RB of Armenia, often under the high categories CR or EN. Meanwhile, the majority of endemic vertebrates are in the RB under the categories VU or DD. Therefore, such species should be additionally studied and probably reassessed in the process of identification of HCVF 1.3. The same is valid for some vertebrate species with narrow areals (mainly reptiles) not registered in the RB. It should be mentioned also that the significant proportion of endemic invertebrate species has never been assessed by IUCN criteria and registered in the RB.

In order to identify sub-type HCVF 1.3 areas with concentration of endemic species it is necessary to consider the characteristics of forest habitats, which ensure the existence of such species as well as their ecological and biological features. In general, the criteria for identification of sub-type HCVF 1.3 are similar to the ones for identification of sub-type HCVF 1.2. The forest ecosystem can be defined as HCVF 1.3 if there are totally at least 5 endemic species of plants and animals in the given forest area. If these endemic species are in the RB of Armenia under the categories CR or EN or they form or have a potential to form large viable populations in the given forest area, then it should be considered as additional conservation value for the area.

4.1.3 Sub-type HCVF 1.4 Critical Seasonal Habitats of Animals

General provisions: Forest areas have critical role for existence and natural development of fauna representatives, such as nesting, breeding and wintering sites as well as rest points along the migration routes, feeding grounds and watering areas, migration routes and others should be defined as HCVF 1 (sub-type 1.4) if there are respective proofs for such a critical role.

In Armenia there are a number of vertebrate animals including rare and endangered ones, which use forest habitats for seasonal concentrations and movements. Usually, these are species typical for open landscapes of upper mountainous zone, which spend winter season in various forest ecosystems. The examples include Caucasian black grouse (*Tetrao mlokosiewiczi*) and Bezoar goat (*Capra aegagrus aegagrus*). Usually the areals, distribution and feeding grounds of such species have more or less constant characteristics if the external conditions and feeding base is stable. This allows identification of forest areas to be defined as HCVF 1 (sub-type 1.4).

4.2 Type HCVF 2. Globally, Regionally or Nationally Significant Large Landscape Level Forests Where Viable Populations of Naturally Occurring Species Have Typical (Natural) Distribution and Abundance

General provisions: The HCVF 2 forests include intact (relatively less affected) and pristine forest areas, where: (1) viable populations of most or all naturally occurring species of plants and animals exist in natural patterns of distribution and abundance; and (2) ongoing ecological processes and ecosystem functioning (e.g. natural disturbance regimes, forest succession, species distributions and abundance) are wholly or relatively unaffected by recent anthropogenic activities. In principle, it means that in case of natural changes of the environment the given size and state of certain forest shall ensure its stable viability and regeneration capacities.

Identification and protection of such forests in Armenia are a priority due to numerous threats to forests of Armenia. More or less intact forest areas existing in Armenia are under the threat of destruction and elimination due to irrational use [3, 23, 24].

According to the guidelines on identification of

HCVFs the forests under this type shall cover large territories. However, "large" can differ in different countries. In countries with large forest areas on relatively flat terrain it is possible delineate forest areas of tens of thousand hectares, whereas in countries like Armenia it is difficult to find intact forests of the size of several hundreds hectares. The signs of direct (loggings, transformation of certain types of vegetation, fragmentation of plant cover) and indirect (presence of settlements and infrastructure, roads of common use, use of lands for agricultural purposes and others) disturbances of natural forest landscapes shall be absent in such areas. Therefore, based on the analysis of forestry activities in Armenia and current data on forest management planning we concluded that an area can be defined as type HCVF 2 area if it meets all of the following criteria:

- Forest landscapes with the size of not less than 300 ha;
- Forest areas not used for timber extraction during the last 50 years;
- Maturing as well as mature and overmature forests;
- Forests with canopy closure 06 and more;
- Forests with fragmentation less than 10%;
- Forest areas without forest cultures.

4.3 Type HCVF 3. Forest Areas Which Contain Rare, Threatened or Endangered Ecosystems

General provisions: The HCVF 3 forests include globally, regionally or nationally rare and/or unique forest ecosystems, which are being quickly reduced due to severe fragmentation and anthropogenic impact. Such forest ecosystems could be rather common in the past, but have been almost fully destroyed due to anthropogenic impact. In some cases forest ecosystems are naturally rare as the climatic or geological conditions necessary for their development are limited.

At present almost all forest landscapes in Armenia can be considered threatened due to existing numerous pressures. Meanwhile, it is obvious that protection of forests with presence of HCV ecosystems is a priority as those areas are under the biggest risk of extinction due to their vulnerability and rare character [3, 25].

The EUNIS (European Nature Information System) classification system adapted to local conditions [26] was used as the basis for identification of such forest ecosystems (or habitats) in Armenia. The EUNIS system has a number of advantages. It is relatively simple and understandable in comparison with the other previously used geo-botanical classifications, it is widely applied in the European countries and it is compatible with the systems used in international treaties.

Meanwhile, long-term detailed and primarily geo-botanical studies are needed to define rare and threatened ecosystems. They assess the representativeness and rare character of any ecosystem. In Armenia, such studies started with the works of the academician A. L. Takhtadjan [4] and then continued by a number of outstanding scientists. Based on their results we defined 17 most rare and most threatened forest habitats (presented below with respective EUNIS code in parenthesis).

(1) Irano-Anatolian mixed riverine forests (G1.37)

(2) Plane grove in Tsav River valley (G1.371-AM)

(3) Riverine forests with *Populus euphratica* dominance (G1.372-AM)

(4) Aspen groves of North Armenia (G1.927-AM)

(5) Lime woodlands (G1.927-AM)

(6) Oak-hornbeam-hazel forests (G1.A7311-AM)

(7) Ponto-Caucasian Scots pine forests (G3.4E)

(8) Grecian juniper (*Juniperus excelsa*) woods (G3.93)

(9) Stinking juniper (*Juniperus foetidissima*) woods (G3.94)

(10) Armenian yew groves (G3.97B-AM)

(11) Mixed forests of *Taxus baccata* and *Fagus orientalis* (G4.91-AM)

(12) *Rhododendron caucasicum* heaths in Armenia (F2.2261-AM)

(13) *Juniperus sabina* scrubs (F2.232)

(14) Sub-alpine crook stem forests (F2.338-AM)

(15) Pear open arid forests (F5.345-AM)

(16) Pomegranate open arid forests (F5.346-AM)

(17) Tamarisk tickets in Armenia (F9.3142-AM)

It is necessary that the territory of HCVF 3 includes the whole rare ecosystem or at least the best or preserved portion of the ecosystem. The minimal size of the type HCVF 3 forest should not be less than 10 ha. If an ecosystem subject to conservation occupies less territory, then 10 ha of the ecosystem with its buffer zone should ensure conditions necessary for its natural development.

The comprehensive assessment of a forest area can identify forest belonging to HCVF 3 if it has at least one rare and/or threatened ecosystem and if it meets the above-described criteria.

It is not recommended to consider an area as HCVF 3 if:

(a) The forest habitat has small size and there are several other similar habitats of bigger size in Armenia or its region;

(b) It is severely degraded in comparison with other similar habitats in Armenia or its region, which are in a better state;

(c) The forest habitat is in unstable phase of successional changes conditioned by natural or anthropogenic factors; and

(d) Similar habitats are protected within existing SPNAs.

4.4 Type HCVF 4. Forest Areas That Provide Special Protection Services

The forest ecosystem services on watershed protection and erosion control are crucial for keeping balance in different ecosystems and safeguarding the standard of living and well-being of people. Identification and protection of HCVF 4 is aimed at reduction of vulnerability of such forests and prevention of risks for ecosystem services they provide.

4.4.1 Sub-type HCVF 4.1 Forests Critical to Watershed Protection

General provisions: The sub-type HCVF 4.1 includes forests adjacent to water objects, such as rivers, lakes and small lakes, wetlands, natural water reservoirs, as well as riparian forests. Such forests should be protected to reduce negative impact of forestry activities on stability of natural streams, water quality and quantity as well as good status of water ecosystems. They should be protected also to ensure species diversity of riparian forests. The demand of water for household, industrial and agricultural needs is increasing and such forests ensure continuous supply of clean water.

The RA legislation defines buffer zone for water objects [21, 27, 28]. In many cases forest ecosystems adjacent to any water object stabilize the littoral area and they often have rich diversity of plants and animals. They provide important habitat and migration routes for a number of mammals and birds as well as stabilize ecologically important vertical and horizontal linkages in landscapes. Forests of the buffer zone have high potential of water absorption. They prevent soil erosion, water pollution and surface runoff, and protect water resources from loss and nearby objects from flood and drought.

Based on the RA legislation (primarily the RA Water Code) and the results of long-term phyto-sociological studies we suggest the following criteria and thresholds for identification of forests under sub-type HCVF 4.1:

(i) Forest areas with the width of 200 m along the rivers and streams with the length of more than 5 km;

(ii) Forest areas with the width of 100 m along the rivers and streams with the length of 3-5 km;

(iii) Forest areas within the radius of 300 m around the main source of drinking water for settlements;

(iv) Forest areas within the radius of 200 m around water reservoirs;

(v) Forest areas within the radius of 100 m around water springs.

4.4.2 Sub-type 4.2 Forests Critical to Erosion Control

General provisions: The sub-type HCVF 4.2 includes forest areas, which by assessment were identified as most vulnerable in terms of soil erosion, landslides, avalanches and others, which in their turn can have severe impact on soil resources and infrastructures as well as human well-being and health.

In Armenia due to irregular loggings during recent decades there are many forest areas prone to erosion, landslides and avalanches. To prevent the mentioned threats, we suggest defining an area as forest under sub-type HCVF 4.2 if it meets one of the following criteria with thresholds:

(i) Forests located on the slopes with inclination of more than 30°.

(ii) Forests with the width of 200 m located nearby settlements on the slopes with high risk of avalanches, with canopy closure 06 and more and minimal forest area of 10 ha.

4.5 Type HCVF 5. Forest Areas Fundamental to Meeting Basic Needs of Local Communities

General provisions: This category includes forest areas having fundamental role for local inhabitants in terms of being irreplaceable for provision of food, water, fuel and medicines as well as serving for hay-making and other means of livelihoods to ensure their existence. Such goods and services provided by forest areas are considered fundamental for communities if there are no other alternatives to obtain them or the available alternatives are not accessible at least during certain period of year.

In Armenia fuel-wood is one of the most fundamental and irreplaceable resources for population, especially in forest adjacent communities with no gas supply or low solvency of population. Meanwhile, to cover fundamental and irreplaceable needs for fuel-wood and other resources the forest adjacent population mainly uses forest areas only within certain distance from communities (about 5 km). However, a forest area cannot be defined as HCVF unless the resource use is sustainable. This is also valid even if the forest dependent communities apply traditional practices. Overuse of resources can compromise the maintenance of other HCVs of the area, for example, rare and endangered species.

Based on the above-mentioned, the forest areas can be defined as HCVF 5 if they meet at least one of the following criteria with thresholds:

(i) The forest is adjacent to a community without gas supply or a community with gas supply, but low solvency of population.

(ii) The forest is adjacent to a community, which has no main road connection to large settlements and temporarily becomes completely isolated from other settlements during certain seasons in the year due to natural unfavorable conditions.

(iii) The forest is adjacent to a community, where at least 40% of the minimum basket of population comes from use of forest resources.

In such communities, the forest area surrounding them within the radius of 5 km shall be considered HCVF 5.

4.6 Type HCVF 6. Forest Areas Critical to Local Communities' Traditional Cultural Identity

This type is suggested in the guidelines. However, in Armenia such forest areas or ecosystems are not present. In Armenia there are "sacred places" and "sacred" or "historical" trees, for example, Plane-tree of Sarigyugh or Plane-tree of Noyemberyan, which are Natural Monuments. Such objects or places cannot be defined as HCVF 6 as they do not form areas or ecosystems.

5. Conclusions

In the result of special studies we developed criteria and suggested methods for identification of forests with HCVs in the conditions of Armenia. The criteria and methods are based on the guidelines [10], but

adapted to the conditions of mountainous forests of Armenia as a small country. It is suggested to define 5 types of HCVFs with respective sub-types. Respective management of identified HCVFs in Armenia shall ensure biodiversity conservation and maintenance of ecosystem services provided by forests.

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