CORUH RIVER DAM PROJECTS AND THEIR ECOLOGICAL IMPACTS

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Coruh river starts from Mescit Mountains of Bayburt, Turkey and reaches Black Sea in Batum, Georgia. The total length of the river is around 431 km. and 410 km of it in the boundries of Turkey and the remaining 21 km in the Georgia. The annual discharge of the river is 6.3 billion cubic meter. Coruh is the fastest running river of the Turkey with an elevational difference of 1420 m. It carries 5.8 million cubic meter of sediment each year. Ten dams are planned to construct on the main river while 21 planned to construct on the branches of the river. They will generate 10.6 billions kWh energy per year. Seven of these dams are located in the vicinity of Artvin. Construction of new roads have also started to solve the transportation problem of the area because some part of the roads are going to be covered by the water. Road construction will damage the forests of the valley due to high slope in the area. Fish species living in the river such as *Salmo trutta labrax*, *Salmo trutta lcapius, Cypirinus carpio, Barbus cycloepsis* and *Silurus glanis* are going to lose their habitat. The region is rich in endemism. The number of endemic species is 119 for Artvin and some of them grows in the main valley of Coruh river. They will lose their habitat after the construction of the dams.

Keywords: habitat loss, endemism, flora, fauna, Artvin

1 Introduction

The world faces a huge challenge to supply the water and energy needs of a rapidly growing population, as well as reducing poverty. Currently, 2 billion people have no access to electricity, while around 1.1 billion people lack access to safe drinking water and 2.4 billion to adequate sanitation services (Anonymous, 2003)

Demand for electricity increases rapidly in Turkey in parallel to population increase. Government has initiated couple of new dam projects to

meet future electricity demand of the Country. One of these projects located at Artvin, on Coruh river. Ten dams are planned to construct on the main river while 21 planned to construct on the branches of the river. They will generate 10.6 billions kWh energy per year. Seven of these dams are located in the vicinity of Artvin. These dams are: Muratli, Borcka, Deriner, Yusufeli, Bayram and Bağlik. They will generate 6.3 billions kWh of energy per year when their construction completed. This accounts for 64% of energy production of Coruh river projects and around 8% of total electricity production of Turkey.

In addition to the three classical criteria of technical, economic and financial feasibility, dam projects have to satisfy social and political acceptance. Today the decisive factor for such acceptance, ranking on a par with dam safety, is compatibility with the environment. Like all the other dams, these dams will create disturbances in the major aquatic and terrestrial habitats of the region and will damage the biological diversity of the area. The impacts of dams and reservoirs on this environment is inevitable and undeniable; land is flooded, people are resettled, the continuity of aquatic life along a river is interrupted, and its runoff modified and often reduced by diversions.

With this paper we aimed to present possible effects of planned dams on environment in Artvin, Turkey. We tried to concentrate mostly effects of dams on flora and fauna of the area. We used current literature and field observations in the Coruh valley to gather data.

2 A general overview of planned dam projects on the Coruh river

Coruh River and its branches provide good potential for the hydroelectric production. This makes the Coruh River one of the most important river in Turkey. Coruh watershed covers 10 140,2 km^2 of area and the total annual discharge of the river is 6.3 billion m^3. It carries 5.8 million cubic meter of sediment each year (Anonymous, 2003). Coruh watershed is one of the heavily eroded watershed of Turkey. The total length of the river is 431 km. and 410 km length of river is in Turkish boundry and the remaining 21 km is in the Georgian boundry. Coruh river is the fastest runing river of the Turkey and it is one of the best river for rafting in the world.

Ten dams have been planned on Coruh river (Figure 1) (Anonymous, 2003). One of the biggest of these dams is Deriner Dam. It is 5 km away from city center of Artvin. When the Deriner dam is completed the mean annual water volume, maximum water level and total lake volume of this dam will be 4847 hm^3, 395 m and 1969 m^3, respectively. The total amount of electricity produced will be 2118 GWh per year.

Another dam will be in Muratli area of Artvin. Mean annual water volume, maximum water level and total lake volume of this dam will be 6000 hm^3, 90 m and 74.8 m^3, respectively. It is planned to produce 115 MW, 444 GWh/yr.

Borcka dam will be 1.5 km away from the town of Borcka. The mean annual water volume, maximum water level and total lake volume of this dam will be 5644.6 hm^3, 185 m and 418.9 m^3, respectively. Annual production of electricity is planned to be 300 MW, 1039 GWh/yr.

Yusufeli dam is located in the south-east of Artvin and it is 40 km away from city centre. It will be built 800 m away from the junction of Coruh River with one of its big branches, Oltu River. Mean annual water volume, maximum water level and total lake volume will be 3777 hm^3, 712.2 m and 2130 m^3 respectively. Annual production of electricity will be 540 MW, 1705 GWh/yr.

Artvin dam is 20 km away from the junction of the Coruh River with one of its big branch, Oltu River, and 30 km away from Yusufeli town. Mean annual water volume, maximum water level and total lake volume will be 3837 hm^3, 511.6 m and 163 m^3 respectively. Annual production of electricity will be 332 MW, 1026 GWh/yr.

Baglik dam is 12 km away from the junction of Coruh and Berta River. Mean annual water volume, maximum water level and total lake volume will be 786 hm^3, 530 m and 7.3 m^3 respectively. Annual production of electricity will be 59 MW, 226 GWh/yr.

Bayram dam is 32 km away from the junction of Coruh and Berta River. Mean annual water volume, maximum water level and total lake volume will be 601.4 hm^3, 740 m and 133 m^3 respectively. Annual production of electricity will be 68 MW, 250 GWh/yr.

When all the planned dams are completed the total power, the annual total energy production and the guaranteed energy production are expected to be 3157.6 MW, 10630 GWh, and 6141 GWh, respectively.

Measures need to be taken to increase the lifetime of dams to prevent filling by sediment deposition. According to a survey done by Reforestation Agency of Government, there are around 100,000 ha area in the Coruh valley that is subject to reforestation, erosion control and rangeland improvement studies. These measures need to be taken as soon as possible to increase lifetime of dams. Currently, Reforestation District of Artvin does 2000 ha of reforestation and erosion control study every year. With current speed, we have to wait for at least another 40 years for these studies to be completed (Tufekcioglu et al., 2004).

3 Impacts of dams on land use in the area

The elevation of the area ranges from 0 to 3937 m (Kackar Mountains). Deep valleys and steep slopes are characteristics of the region. Diverse

topography of the region creates different climate types in the area. Annual precipitation changes from 200 mm to 2000 mm in the region with higher values being in the coast. Air moving from Black Sea towards inner part of the valley cools when it forced to pass coastal mountains and drops lots of rainfall on the coast (Kantarcı, 1995).

Major land use in Artvin is forest (52%). Rangelands cover around 17.6% and cultivated land is 4.3% of the remaining area of the city (Table 1) (Tufekcioglu et al., 2004b).

Table 1: Distribution of land-use types in Artvin

Total Area (ha)	Cultivated land		Forest		Rangelands		Other	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
744.799,4	32.019,5	4,3	390.662,5	52,5	130.810,5	17,6	188.306,9	25,3

Soils of the region are generally shallow with very high rock contents. Soils are suitable for the cultivation around 1% of the total city area (Table 2). Major land use classes in the Artvin are V, VI, VII and VIII. These type of lands are only suitable for forest and rangelands (Tufekcioglu et al., 2004b)

Table 2. Distribution of soil classes in Artvin

Class I (ha)	Class II (ha)	Class III (ha)	Class IV (ha)	Class V-VIII (ha)	Other (ha)	Total Area (ha)
83	2138	4768	27222	709375.4	1213	744799,4
0.01%	0.2%	0.6%	3.6%	95.2%	0.1%	

Most of the sites in Coruh river basin are used for forestry activities and areas above timberline are used for grazing. Sites with low slopes in riparian area of Coruh river are used for agriculture. But these areas are so limited that people cannot get enough income for living. Therefore, people tillage steep areas for agricultural purposes around the settlements. They cultivate corn, wheat, hazelnut, olive and tea in these areas. Around 40% of the productive cultivation land will be covered by water. Government has paid to those farmers whose land will be covered by water. Almost 90 percent of olive gardens will be under water. Measures need to be taken to protect Artvin's olive gardens which is famous for its big fruits. Soil erosion in agricultural lands converted from forest into cultivation is a threat to dams' lifetime.

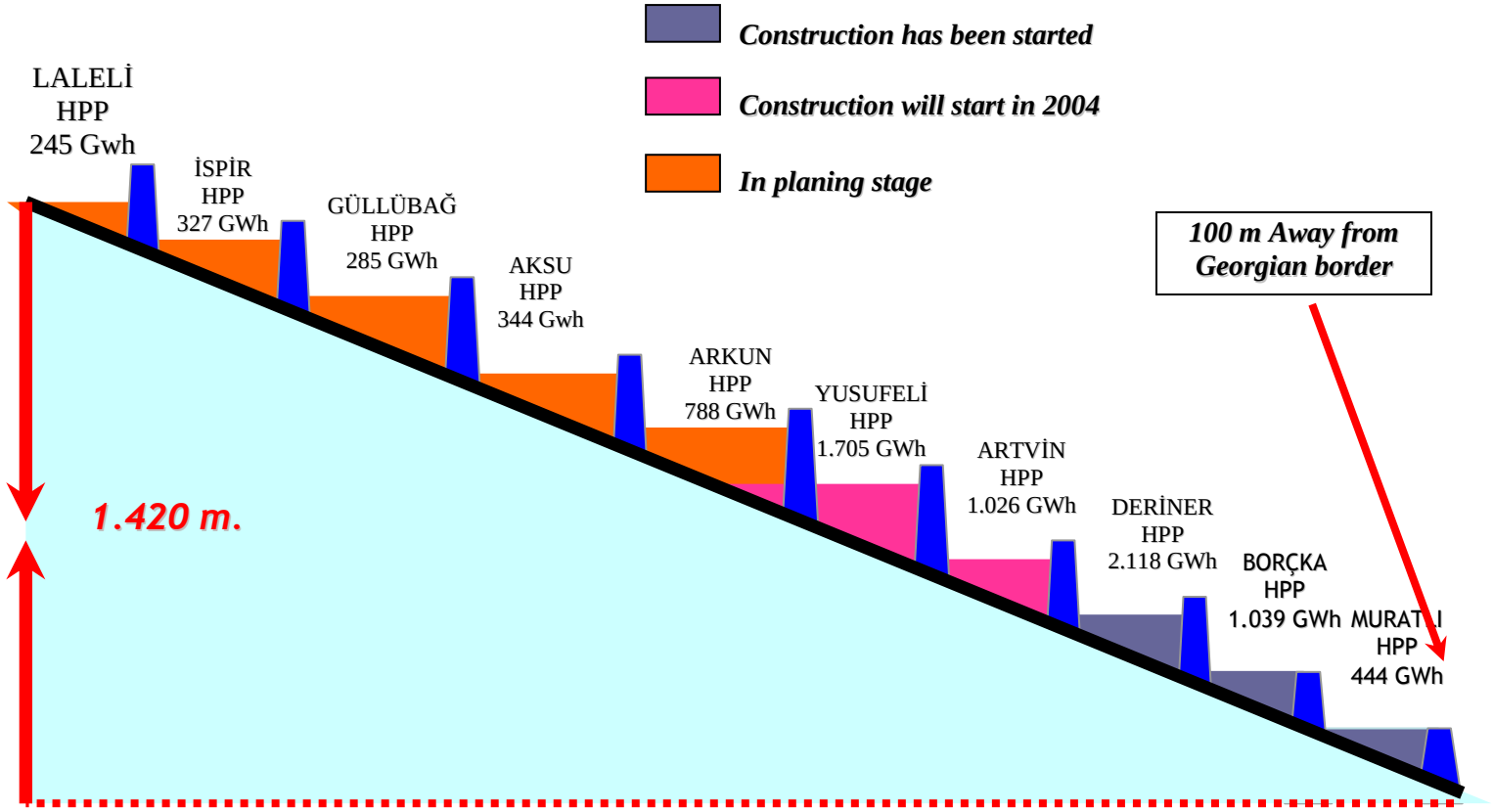

Figure 1. Cross-sectional diagram of dam projects on Coruh river

4 Impacts of dams on flora of the watershed

Flora of Coruh River has lots of similarities with Caucasian Flora. The area remains in the Colchis province of Euro-Siberian Flora Region of Turkey. However, bottom of the valley has plant species originally belongs to Irano-Turanien and Mediterranien flora Region of Turkey. Species from Mediterranien region decrease with increasing altitude.

A riparian vegetation including mostly deciduous trees and shrubs spreads through the bottom of the Coruh valley on alluvial soils. These species are: *Platanus orientalis L., Juglans regia L., Salix alba L., Salix viminalis L.,Populus usbekistanica Kom.ssp. usbekistanica cv. "Afganica", Populus tremula L., Alnus glutinosa (L.) Gaertn. Subsp. barbata (C.A.Mey.)Yalt., Ficus carica L., Acer campestre L., Tamarix smyrnensis Bunge, Hippophae rhamnoides L., Clematis vitalpa L., Mentha pulegium L., Ranunculus repens L., Ranunculus ficaria L., Saxifraga cymbalaria L., Cyclamen coum Mill. Tussilago farfara L., Nasturtium officinale R. Br.*

Above this humid riparian vegetation, there is a herbaceous vegetation with occasional openings in some stands and degraded in some part. Plant species in this belt are: *Quercus petraea L., Carpinus orientalis L., Juniperus oxycedrus L., Juniperus excelsa Bieb., Juniperus foetidissima Willd., Paliurus spina-christii Mill., Cornus mas L., Acer tataricum L., Acer divergens L., Rhamnus pallasia Fissh. Et Mey., Crataegus monogyna Jacq., Rosa canina L., Colutea armena Boiss. Et. Huet., Berberis vulgaris L., Cotoneaster morulus Pojk., Cistus creticus L., Rhus coriaria L., Capparis ovata Desf. Var. herbacea (Wild.) Zoh..*

Species spreading between 750- 1200 m altitudes are: *Fagus orientalis Lipsky., Ulmus glabra Huds., Tilia rubra DC.Subsp. Caucasica (Rupr.) V. Engler. , Carpinus betulus L., Acer cappadocicum Gleditsch., Acer platanoides L., Quercus hartwissiana Stev., Quercus pontica C. Koch., Sorbus torminalis (L.) Crantz., Sorbus acuparia L., Picea orientalis L., Pinus sylvestris L., Abies nordmanniana (Stev.) Spach., Taxus baccata l., Buxus sempervirens L., Rhododendron ponticum L., Rhododendron luteum Sweet., Rhododendron caucasium Pall., Sambucus nigra L. , Vaccinium arctostaphylos L., Mespilus germanica L. Lonicera caucasica Pallas, Acer cappadocicum Gledit., Acer trautvetteri Medw., Acer paltanıoides L., Castanea sativa Mill., Ostrya carpinifolia Scop., Carpinus betulus L., Diospyrus lotus L., Rhododendron smirnovii Tratv., Rhododendron ungernii Traurv., Osmanthus decorus (Boiss & Ball.), Daphne pontica L., Quercus pontica C.Koch., Betula medwediewii Regel., Rhamnus imeretinus Booth., Rosa elymaitinus Bois. Et Hausskn., Rosa villosa L., Papaver lateritium Koch., Lilium monadelphum Bieb. Viola sieheana Becker., Alyssum artvinense Busch..*

In this forest zone, some rare plant species, for example, *Rhododendron smirnovii Tratv., Rhododendron ungernii Traurv. Rhododendron caucasium Pall., Rhamnus imeretinus Booth., Epigaea gaultheroides (Boiss. Et Ball)*

Takth, Papaver lateritium Koch., Lilium monadelphum Bieb., Alyssum artvinense Busch exist and they are endemic plant species for the region of Artvin and Caucasia. These rare plants will not be affected by the dam construction since they mostly occur on the upper part of the valley.

Some important crop species existing on the dam areas are: *Olea europaea* L. var. europaea, *Vitis vinifera* L., *Morus alba* L., *Punica granatum* L., *Cerasus avium* (L.) Moench., *Persica vulgaris* Mill., *Pyrus communis* L. *Prunus cerasus* L. *Prunus x domestica* L., *Ficus carica* L., *Juglans regia* L., *Malus silvestris* Mill., *Zea mays* L., *Phaseolus vulgaris* L., *Solanum tuberosum* L. and *Lycopersicom esculentum* Miller. Local people generally grow these crops for their own needs. But the amount of crop is not enough for exporting to other cities due to the limited available agricultural land in the region.

At the reservoir of Borçka dam valley in Naşviye (Fıstıklı Village), there is a small area covered by umbrella pine (*Pinus pinea* L.) stands (about 100-150 ha area, with a normal canopy closure) (Tufekcioglu et al., 2002). Many scientists have given some attention to these pine stands since umbrella pine is known as an important Mediterranean species. Miroz (1967) stated that these pine trees were naturally grown in this region. But Zohary (1973) determined that in Artvin A8 square, the origin of these trees were derived from the relic of Mediterranean species in ancient geological times. A part from the umbrella pine, Ansin (1980) determined some other Mediterranean species in the area. Some of these are: *Punica granatum* L., *Laurus nobilis* L., *Jasninum fruticans* L., *Cistus creticus* L., *Olea europaea* L. *var. oleaster*, *Arbutus andrachne* L. and *Phyllirea latifolia* L.. He stated that all of these species were naturally grown in this region and they migrated to area through Anatolian cross which is a line extending from Gumushane-Bayburt to Kahramanmaras-Iskenderun regions due to climate changes in the past.

Some plant species determined in this small umbrella pine stands are: *Pinus pinea* L., *Quercus petraea* (Matt.) Liebl. subsp. *iberica* (Stev.) Krassilin, *Phyllirea latifolia* L., *Juniperus oxycedrus* L., *Paliurus spina-christii* Mill., *Cornus mas* L., *Acer divergens* Pax., *Rhamnus pallasi* Fisch. Et Mey., *Rosa canina* L., *Colutea armena* Boiss. Et Huet, *Berberis crataegina* DC., *Cotoneaster morulus* Pojk., *Pistacia terepinthus* L. subsp. *palaestina* (Boiss.) Engler, *Capparis ovata* Desf. var. *herbacea* (Willd.) Zoh., *Cistus creticus* L., *Rhus cariaria* L., *Cotynus coggygria* Scop., *Arbutus andrachne* L., *Laurus nobilis* and *Jasminum fruticans* L., *Teucrium polinum* L., *Erynggium campastre* L. var. *virens* Link., *Convolvulus cantabrica* L., *Acantholimon libanoticum* Boiss., *Ruscus aculeatus* L., *Helianthemum nummullarium* (L.) Mill., *Xeranthemum annuum* L., *Muscari armeniacum* Leichtlin ex Baker, *Primula vulgaris* Huds., *Tussilago farfara* L., *Viola odorata* L., *Morina persica* L., *Galium aparine* L., *Galium coronatum* Sibth. Et Sm., *Hypericum pruniatum* Boiss. Et Ball. and *Lotus suaveolens* Pers.

Some part of these umbrella pine stands will be covered by the water of Borcka dam. These stands need to be protected as genetic resource since they

might be differentiated from the main stands of the species in terms of genetic structure.

There are total of 1268 plant species and 120 of these are endemic (grows only Artvin) for Artvin (Davis et al., 1965-1988). Some of these endemic plants are endangered plant species. There are 4 critically endangered, 18 endangered and 12 data deficient species in the Artvin (Ekim et al., 2000). List of critically endangered (CR), endangered (EN) and data deficient (DD) species are given below:

Anthemis calcarea var. *calcarea* (CR), *Centaurea leptophylla* (CR), *Hypericum fissurale* (CR), *Lathyrus woronowii* (CR), *Onosma circinnatum* (EN), *Symphytum savvalense* (EN), *Campanula choruhensis* (EN), *Campanula troegerae* (EN), *Silene scythicina* (EN), *Rhodothamnus sessilifolius* (EN), *Helichrysum artvinense* (EN), *Hieracium diaphanoidiceps* (EN), *Hieracum foliosissimum* (EN), *Hieracium radiatellum* (EN), *Clypeola raddeana* (EN), *Hypericum marginatum* (EN), *Crocus biflorus* subsp. *artvinensis* (EN), *Crocus biflorus* subsp. *fibroannulatus* (EN), *Stachys choruhensis* (EN), *Lilium carniolicum* subsp. *ponticum* var. *artvinense* (EN), *Ornithogalum byzantinum* var. *proliferum* (EN), *Orobanche armena* (EN), *Heracleum sphondylium* subsp. *artvinense* (EN), *Hieracum artvinense* (DD), *Hieracium cinereostriatum* (DD), *Hieracium debilescens* (DD), *Hieracium floccicomatum* (DD), *Hieracium subartvinense* (DD), *Hieracium subhastulatum* (DD), *Hieracium virosiforme* (DD), *Astragalus imbricatus* (DD), *Allium koenigianum* (DD), *Gagea tenuissima* (DD), *Verbascum artvinense* (DD), *Ferulago latiloba* (DD).

Some of these species grows in high altitudes and therefore they are not subject to any negative impact from dams. However, growing area of some plant species listed above, and growing area of couple of other endemic species will be covered by the reservoir of the dams. These species are:

Centaurea hedgei(end.), Centaurea pecho (end.), Hypericum fissurale (CR), *Lathyrus woronowii* (CR), *Onosma circinnatum* (EN), *Campanula choruhensis* (EN), *Campanula troegerae* (EN), *Helichrysum artvinense* (EN), *Hieracium diaphanoidiceps* (EN), *Hypericum marginatum* (EN), *Crocus biflorus* subsp. *artvinensis* (EN), *Stachys choruhensis* (EN), *Ornithogalum byzantinum* var. *proliferum* (EN), *Hieracium debilescens* (DD), *Astragalus imbricatus* (DD), *Allium koenigianum* (DD), *Gagea tenuissima* (DD), *Verbascum artvinense* (DD), *Ferulago latiloba* (DD), *Sempervivum staintonii (end.), Sempervivum glabrifolium (end.), Acer divergens var. divergens (end.), Chesneya elegans (end.).*

These species need to be transferred into botonical gardens and cultivated before dams start holding water. Contrary to our findings, General Directorate of State Water Works(DSI) claims in its Environmental Assessment Report that there is no endemic species in the reservoir area of Deriner dam (Anonymous, 1994).

5 Impacts of dams on fauna of the Watershed

Mamals living n the area are: *Cervus elaphus, Capreolus capreolus, Capra aegagrus (vulnerable(VU), Rupicarpa rupicarpa, Sus scrofa, Ursus arctos, Vulpes vulpes, Lynx lynx, Canis lupus, Canis aureus, Meles meles, Lutra lutra, Martes martes, Mustela nivalis, Sciurus vulgaris, Caster fiber, Martes foina Rinolophus hippocideros (VU) and Lepus europaeus.* Construction of dams will eliminate the some of the areas these animals live in cold winters. They also will have difficulty to pass into west and east slopes of the walley.

Important reptailes living in the area are: *Vipera kaznakovi* (EN)(hopa viper) and *Vipera pontica* (CR) (coruh viper). Both species uses areas that will be under the water in the near future and they both are under high risk due to dam construction. They both need serious protection measures.

Coruh Valley is one of the important north-south bird route of migrating birds. In this respect, dams will create habitats that suitable for birds during this migration period.

Birds living in the area are: *Tetrao mlokosiewiczi (end.), Tetraogallus caspius (end.), Alectoris chukar, Coturnix coturnix, Stoptopelia tırtır, Scolopa rusticola, Lanius minor, Otis tarda ve Lanius collurio, Ixobrycus minutus, Botaurus stellaris, Columba livia, Columba palumbus, Turdus pilaris, Turdus merula, Oriolus oriolus, Anas platryhynchos, Anas strepea, Falco naumanni (VU), Falco elanore, Circus cyaneus, Circus macrourus, Falco cherrug, Falco colimbarius, Falco tinnunculus, Accipiter nisus, Accipiter brevipes, Gyps fulvus, Neophron percnopterus, Circaetus gallicus, Aquila chrysaetos, Aquila heliaca (VU), Crex crex (VU), Aquila rapax, Pandion haliaetus, Buteo lagopus and Milvus milvus* (Ertan et al., 1989).

There are couple of fish species living in the Coruh river. These are: *Salmo trutta labrax, Salmo trutta lcapius, Cypirinus carpio, Barbus cycloepsis and Silurus glanis*. They will lose most of their habitat due to dams.

Finally, construction of new roads to solve transportation problem of the area will damage the forests in the slopes of the valley due to steep slope in the region. Around 40 villages and 1 town have to be resettled due to dam construction (Anonymous, 2003).

6 Conclusions and suggestions

Dams disrupt the ecological balance of rivers by depleting them of oxygen and nutrients, and affecting the migration and reproduction of fish and other freshwater species. In Coruh watershed, around 23 endemic and 11 endangered plant species, 2 reptile species and 5 fish species will partially or totally lose their habitat. Wild animals living in the area will have difficulty to pass into east and west slopes of the area.

A botanical garden need to be established in the area. Endemic and endangered plant species living in the dam area must be transplanted into this botanical garden if it is possible or seed of them must be collected to grow them in botanical garden.

Currently, two reptile species, Coruh viper and Hopa viper are close to be extinct (especially Coruh viper). With the construction of dams they will be in real danger due to habitat loss. Special measures such as establishment of a protected area need to be taken for these two species.

A new comprehensive Environmental Impact Assessment needs to be done in the area. First environmental impact assesment report claims that there are no endemic plant species in reservoir area of Deriner. Our results showed that this wasn't true.

As the population of the country grows, Turkey will need more electrical energy and will built dams on its rivers, but special attention should be paid to any effects on biodiversity or the habitat of rare or endangered species. As soon as the project becomes operational, its impact on the environment should be assessed at regular intervals, based on data and sources resulting from adequate pre-construction monitoring. Depending on the individual situation, certain critical parameters should be monitored as a basis for a subsequent performance analysis of the project, resulting in a beter understanding of its interactions with the environment.

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