The Amur River: from the Daurian steppe to the Sea of Okhotsk

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The Amur is one of the ten world greatest rivers, but is the least known large transboundary river basin that is definitely worth close attention of scientific and conservation community. This river system is bigger than Danube, Yangtze or Mekong, let alone Rhine or Oder, and in contrast to all those it still retains most of its free-flowing character. Almost 3,500 kilometers of the border between Russia, China and Mongolia is formed by shared river courses and adjacent wetlands, creating a unique challenge for transboundary cooperation in Integrated River Basin Management (IRBM) implementation. The area includes four WWF Global 200 priority ecoregions: the Amur-Heilong freshwater ecoregion itself, the Russian Far Eastern temperate forests, the Daurian wetland-steppe, and the Amur-Heilong River discharge from 2.1 millions square kilometers watershed greatly impacts global marine ecoregion – Sea of Okhotsk.

Figure1. Location of Amur River basin.

Country	Total Area (km^2)	Area in Amur River Basin (km^2)	Percent in Amur River Basin
Russia	16,995,800	1,008,000	6
China	9,326,410	905,700	10
Mongolia	1,565,000	189,000-224,000	12-14
DPRK	120,410	100	0,09
Total Amur Basin		**2,109,000 - 2,144,000**	

Table 1. Amur River basin area by country and reach of the basin (Simonov & Dahmer, 2008)

With species from the northern boreal, temperate and subtropical biomes, the Amur River basin supports a tremendous biodiversity. When compared with other river basins of Eurasia at similar latitudes, the Amur is richer in terms of fish species diversity and there is greater number of large river ecosystem units - freshwater ecoregions. The Amur is important habitat for about 130 native freshwater fish species, and critical habitat for 18 species and one genus *(Pseudaspius)* that are endemic to the basin (Novomodny et al, 2004). Endemic populations of the famous Amur sturgeon (*Accipenser schrencki*) and Kaluga *(Huso dauricus*), both are listed as Endangered in the IUCN Red List of globally threatened species (see www.redlist.org). The Amur River still supports tremendous resources of migratory salmon, including seven species, with O*ncorhynhus keta* being the most abundant.

Natural Resources		**Biodiversity Richness**	
Freshwater	346 km^3 /year	Freshwater algae	2600 species
Salmon (maximum year harvest)	100 million kg	Vascular plants	2800 species
Sturgeon (maximum year harvest)	1,2 million kg	Insects	40000 species
Arable lands	6 million hectares	Fish	130 species
Timber stands	15 billion km^3	Amphibians and reptiles	23 species
Timber annual harvest	20 million km^3	Birds	380 species
Gold mining	30 tones annually	Mammals	90 species

Table 2. Biodiversity richness and natural resources in Russian portion of Amur River Basin (Darman et al., 2003).

The floodplains of the Amur-Heilong and its tributaries serve as an important link in the chain of stopover and nesting sites for millions of migratory birds of three major transcontinental flyways. As much as 95 percent of the world's nesting population of Oriental storks (Ciconia boyciana) is found in the Amur-Heilong floodplain, along with 65 percent of the red-crowned crane (Grus japonensis) and 90 percent of the white-naped crane (Grus vipio) populations.

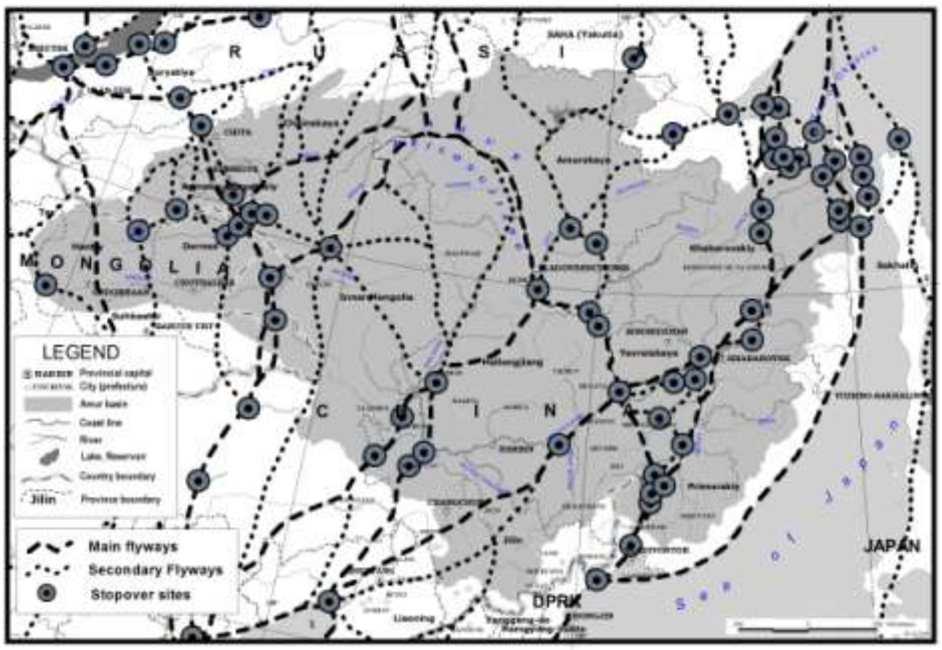

Figure 2. Bird migration routes in Amur River basin.

Floods are one of the most important natural processes and determine, in part, the diversity and productivity of the Amur ecosystems. The shaping and dynamics of the vast floodplain wetlands, the major nutrient cycles, and the life-cycles of all aquatic flora and fauna depend primarily on the periodicity, volume, and other characteristics of floods. Even so, water is in short supply throughout most of the basin during the much longer dry season and droughts are critically important for ecosystem dynamics in western part of the Amur River basin. Temperatures in the eastern Amur basin have risen +0.6 °C and more that +2.0 °C in its up-stream. The temperature also becomes less stable, especially in summer, in the direction from east to west. The total precipitation has somewhat decreased over the last century. The atmospheric precipitation has become more unstable in all seasons (and between years) during the latest decades, especially in the eastern portion of the catchment.

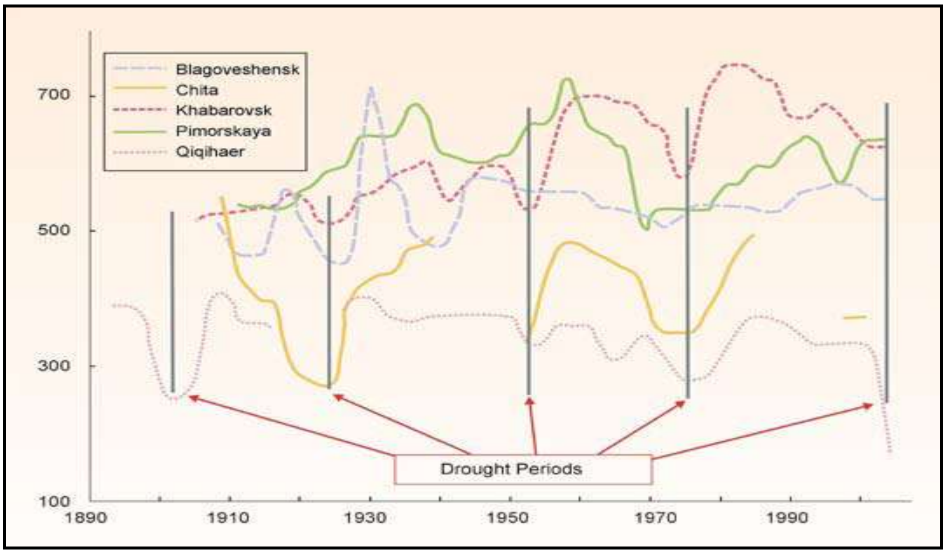

Figure 3. Long-term precipitation cycles in the Amur River basin based on records of major hydro meteorological observatories (Parilov et al., 2005). Red arrows show draughts.

The importance of the issue has been raised with an aggravation of ecological problems in the region since the 1990s: rivers going shallow in summer, fish die-off in winter, dust storms in spring, and extensive forest, grassland and peatland fires. Ecosystems in the basin are vulnerable to any abrupt changes and are already actively evolving in response to modified climate patterns. Results obtained in a number of nature reserves in the Russian Far East (Darman et al, 2006) prove that biological communities and organisms are affected not by an increase in mean annual temperature alone, but by a complex of environmental changes caused by the warming; moreover, human activities affect them much more than the climatic fluctuations observed. The reactions of biological communities manifest themselves in shifts of phenological phases, in changes of animal numbers and behaviour, and in succession of vegetation communities.

Human activities are also changing in response to natural shifts and with raising awareness even in response to mere anticipation of climate change. Land use changes result from a complex interplay of many factors, but climate change is definitely one of them. Because the conversion of wetlands to agriculture occurs most easily at the fringes of wetlands in dry years, a dryer climate and more pronounced droughts result in increased conversion of wetlands. The same holds for the desiccation of natural wetlands as result of an overexploitation of aquifers and surface waters through irrigation. According to water management authorities Russia's share of the flow is 257.8 km^3 (71%), while China accounts for 103.7 km^3 (28.5%) and Mongolia only 2 km^3 (0.5%). Natural flow is uneven, with more than 80% of flow volume during May-October, and more than 40% reduction in annual flow during dry years. Shortage of water is already a key issue in many sectors in China that affects agriculture, municipal supply, and sustaining environmental flows and key ecological processes (Shen Guo Fang, 2006). 6 tributaries of Songhua Rivers regularly dry up and do not reach river mouth. Total area of mires, fens and bogs in the Northeast China has decreased 42.4% in 50 years from 114 000 sq.km to 66000 sq.km. Area of salinization and alkalinization in Song-Nen Plain reaches 37000 sq.km, and situation worsens as aridizations goes on.

Desertification occured on 80000 sq kilometers in 3 western areas: Ke'erqin (62431 sq km), Song-Nen (7849 sq km) and Hulunbeier (7435 sq.km). Wetland nature reserves of Ke'erqin, Momoge, Zhalong, Xianghai, all are drying up and degrading rapidly.

Despite seeming abundance of water in Russia, ecological flows have been disrupted and shortages are evident especially for fisheries and floodplain wetlands. These results from the impact of the Zeya and Bureya dams, which holds totally about 89 cubic kilometers of water, reduce flood peaks and thus make flooding of many wetland areas much less frequent. Detectable changes in flood levels can be traced at least 1,200 kilometers downstream. Most extensively environmental effects on wetland ecosystem and rare birds were studied in Khingansky nature reserve. There are further plans to develop new giant dams on tributaries, and even on the main stem of Amur River, driven primarily by China demand for electricity.

Climate change and draught coupled with unsustainable land-use practices led to dessication of many rivers, wetlands and lakes in Eastern Mongolia in last decades. Ecosystems are very vulnerable to even moderate alterations of water flow. Therefore some known development plans evoke considerable concern. "Draft resolution on Development of Proposals on Transfer of Part of Water to Gobi and Steppe Areas Through Flow Adjustment in Selenge, Onon, and Balj Rivers" was listed on agenda of the Mongolian Parliament in March 2006. In some river basins (Kherulen and Onon included) irrigation schemes are planned to be implemented using financial aid from abroad. Although unable to influence Amur itself these projects might have profound environmental impacts on wetlands and steppes of Dornod Province, which already suffers from water shortage, that resulted in mass migration of Mongolian gazelle to Russia forest-steppe zone.

Water management in the Amur-Heilong River basin is largely unsustainable in all three basin countries and is based on very different premises and policies. Given current development patterns, these factors will lead to a massive use of water resources and to the construction of large reservoirs as the most effective means of water diversion. There is an obvious need for careful, international planning to adapt to climate change both in the Amur headwaters and across the entire basin as well. We can predict that current, wasteful water management policies coupled with projected climate change will:

- further increase aridization of natural landscapes;
- decrease surface water flows in river courses;
- further decrease water resources available for use; and
- increase levels of pollution in watercourses.

The most rapid change happens in Dauria, where the increasing occurrences of large-scale forest and grass fires in all three countries are well correlated to rates of global warming. The obvious and immediate threat in the sphere of water management comes from a series of water transfers planned for the already water-deficient Kherlen, Onon, Argun/Hailaer Rivers. A channel from the Hailaer River to Dalai Lake, is already almost complete and will divert at least 30% of the Hailaer/Argun River (1.05 km^3) into China's Dalai Lake. For the wetlands and agrarian communities downstream from the channel in China and Russia such a significant decrease in water supply would cause irreparable destruction. Reservoirs upstream from channel further reduce river flow and help to cut off floods that sustain Argun River wetlands.

We are reasonably sure that such water transfer will threaten globally important wetland ecosystems, water sources and probably even boundary demarcation in the area where the Argun River forms the China-Russia border. Such water policy precludes Russia, China and Mongolia from any coordinated, equitable and ecologically-sound transboundary water management regime in the Amur River headwaters and leads to major maladaptation to climate change. Argun River needs to secure internationally the environmental flow sufficient to sustain its floodplain wetlands. In contrast to these aggressive water transfer schemes and reservoir-building race, a more appropriate use of the Upper Amur would be to test international cooperation in adapting water use and conservation measures for large ecosystems characterized by periodic droughts.

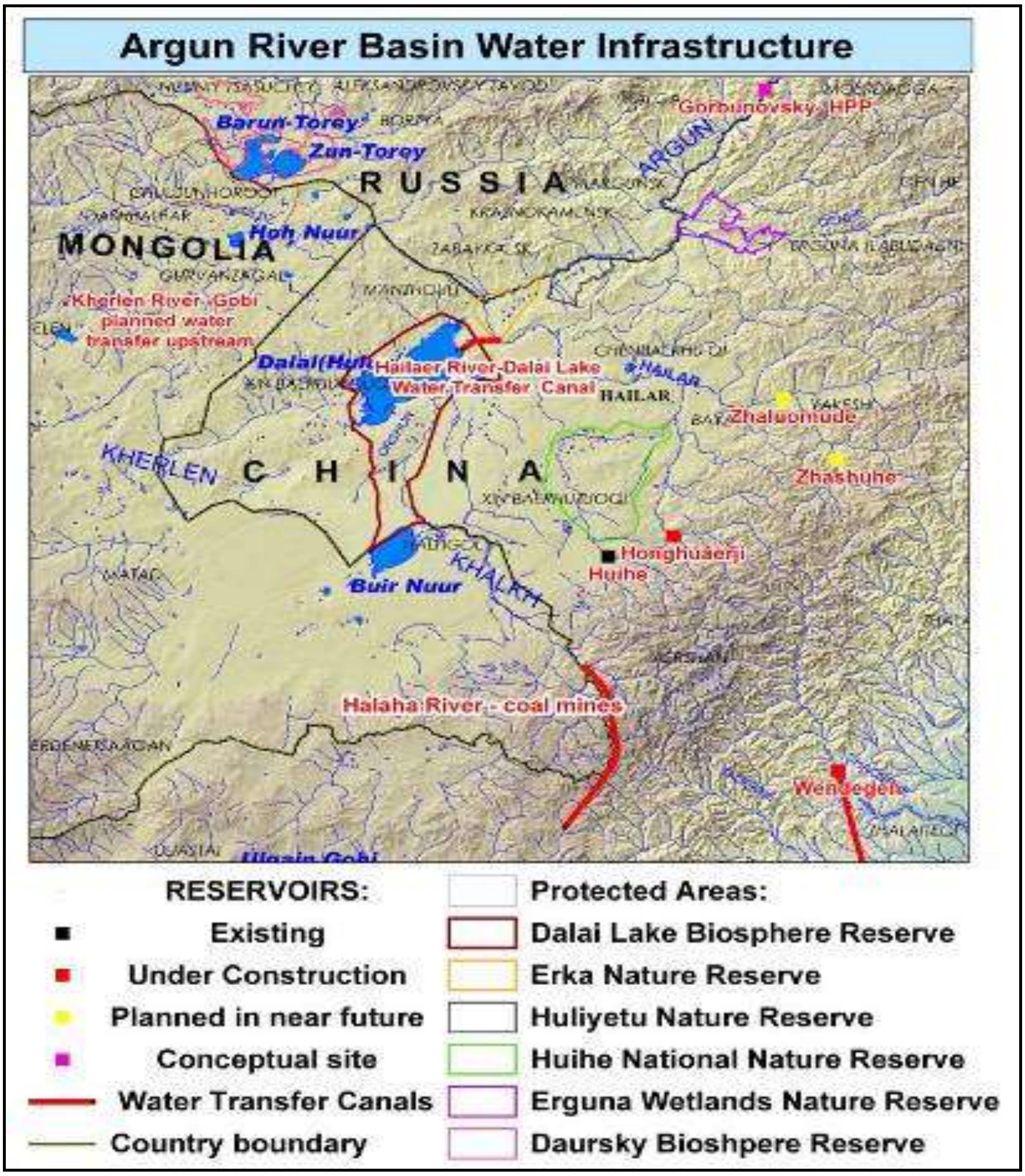

Figure 4. Water Infrastructure projects for the rivers in Dauria Ecoregion (from http://dauriarivers.org/).

Another key, long-term threat to the ecosystem is tapping into the Amur River main channel water resources to generate electricity and alleviate the growing water crisis in the southwest portion of the basin and adjacent river basins. This is driven mainly by China's inability to reverse unsustainable patterns of resource use and by Russia's willingness to increase exports of natural resources to serve China's growing needs. Such a move will spread the water crisis now unfolding in neighbouring China basins (Liao, Yellow and Huai Rivers) to the Amur Basin (Simonov et al, 2006). Hydropower development in the main stem of the Amur River will move the basin toward this scenario and this development will catastrophically alter the basin ecosystem. Development of additional hydroelectric dams on yet untapped tributaries in Russia will massively degrade the basin's ecosystem and will cause a decline in biological productivity and biodiversity. Development is driven by Russia's intent to export unlimited volumes of natural resource to China and reflected in "Joint Sino-Russian Comprehensive Scheme for Water Resource Management of Transboundary Parts of Argun and Amur Rivers"drafted before 2000. Implementation of the Joint Scheme with 3 reservoirs on the main channel of the Amur River would result in radical alteration of hydrological and ecosystem processes throughout the basin. Beyond obvious generic impacts from inundation by reservoirs, most notable effects include radical changes in sedimentation patterns in the Lower Amur, creation of an impenetrable barrier for migrating fish, and significant alteration of the wetland hydrological regime of the Amur-Heilong valley downstream.

Current policies on flood-prevention and river-bank development largely neglect natural processes of river ecosystems. It is mainly in the transboundary locations where the governments continue to employ outdated infrastructure solutions. Unless Russia and China agree to a common strategy for adapting to the flood regime and meandering river channel, it is probable that the pattern of unsustainable development will persist. The most obvious result – would be increasing damage from catastrophic floods along the main channel, after it is constrained by more embankments. This would be followed by increasing demand to build larger dams to control these floods.

The lack of cooperation between countries and the highly technocratic mode of this cooperation when it does occur increases the risks from the most negative development scenarios. There are no joint environmental agencies, research institutions, or environmental databases for the Amur River basin. Most innovative and comprehensive studies of the Amur recently were produced by NGOs or international projects funded by other countries. For example "pollution" is widely recognized transboundary problem in Amur River Basin. However chemical composition of river waters has many other meanings of regional ecological and economic importance. This is emphasized by Japanese Institute of Humanity and Nature that started "Amur – Okhotsk Project" clarifying the relationship between the Amur River basin and the ecosystem in the Sea of Okhotsk and the eastern North Pacific. Now scientists are quite certain that they are strongly connected by dissolved iron. They call this system "Giant" Fish-Breeding Forest (GFBF) and study influence of human impacts on river discharge in order to propose an agenda to conserve this system with minimal limitations on human activities in the Amur River basin (Shiraiwa, 2007).

Building system of transboundary protected areas is an essential component of any larger set of common environmental policies, and is both a need and likelihood it can be pursued in shorter timeframe that many other components, since these questions seem to be less sensitive than pollution control, sharing water resources or assessing environmental impacts of infrastructure. However, we will see that planning and implementing a comprehensive system of transboundary protected areas requires taking in consideration wider environmental factors and policies. Keeping this in mind WWF proposes development of the Amur-Heilong Green Belt, an ecological network of protected areas, connected by buffers zone and corridors, with special emphasis on ecosystems adjacent to international borders. Due to special place of freshwater ecosystems in transboundary conservation policies and smaller attention they were given in previous programs we mostly focus on wetland areas and areas adjacent to river boundaries. During last 15 years, Amur branch of WWF Russia, in cooperation with provincial governments and local NGOs, were succeeded in establishment of 4,6 million hectares of new national parks, nature reserves and wildlife refuges, enlarging the system of protected areas up to 8,1% of Russian portion of basin territory. And that is one of major IRBM steps for adaptation for climate change and anthropogenic development.

Country	**Total Protected areas**			**National Protected areas**			**Provincial/Local Protected areas**		
	n	area (km^2)	%% of basin	n	area (km^2)	%% of basin	n	area (km^2)	%% of basin
China	268	135,046	15	27	37,714	4.2	241	97,332	10.8
Mongolia	8	19,748	8.8	4	11,677	4.8	4	8,281	3.7
Russia	460	80,850	8.1	20	28,620	2.9	440	52,220	5.2
Amur-Heilong basin	**736**	**235,644**	**11.1**	**50**	**78,013**	**3.6**	**641**	**130,559**	**7.5**

Table 3. Protected areas in Amur-Heilong River basin (as at the end of 2005).

The importance of Amur-Heilong River basin and its protected areas is recognized by virtually all global assessment and listing systems. The basin has 15 Ramsar Wetlands of International Importance, 10 Man and Biosphere Reserves, 1 World Heritage Site, 75 Important Birds Areas. These wetlands are ideally suited to coordinated management using the Ramsar Convention’s regional, river basin approach. WWF offices in Russian Far East, North East China and Eastern Mongolia close collaborate with governments of 10 provinces in 3 countries to create a system of protected areas connecting by water protection zones and keep main stream of Amur free of dams. Necessity to establish Amur-Heilong-Onon Ramsar initiative was acknowledged by 2005 Ramsar Asian regional meeting in Beijing in May 2005, then it was proposed by the IV meeting of China-Mongolia-Russia transboundary Dauria International Protected Area in March 2006, finally “strategic action for conservation of transboundary wetlands” was included into the workplan endorsed by the First Meeting of Biodiversity Working group of Sino-Russian Environmental Cooperation Subcommittee in Harbin in May 2007. The idea was also presented and discussed at special side meeting during Ramsar COP10 in South Korea in 2008. From WWF perspective it could make an ideal initial Amur-Heilong IRBM forum, since it addresses all necessary issues from quite agreeable and neutral platform of preserving integrity of great wetland ecosystem of the river basin.

Rapidly deteriorating environmental conditions in the Amur River Basin call for formation of effective national and international programs on environmental management. These should address critical needs to reduce pollution, restore fish stocks, sustain and use the natural functions of the basin ecosystem instead of degrading them in exchange for questionable short-term gain. Water management lies at heart of all these problems and should be monitored and planned in a concerted cooperative effort involving Russia, China and Mongolia. There are several broad guidelines that are highly relevant to the Amur IRBM:

1. Use of water resources in the basin should be based on comprehensive needs and opportunities assessment taking into account all interested sectors of society (stakeholders) and needs of natural riverine ecosystems. No longer can all other needs be sacrificed for the sake of energy production.

2. Cumulative environmental and socio-economic effects of the Bureya and Zeya dams, as well as dams in the Songhua and Argun river basins, should be subject to detailed assessment and monitoring. Mitigation and compensatory measures should be planned and implemented at the expense of water infrastructure owners .

3. Old, obsolete large-dam projects planned in the past should not be implemented, especially those altering the main channel of the Amur River. Strategic environmental assessment of many options is needed before any further hydropower development plans go ahead in river basin.

4. The roles of floods and wetlands in sustaining environmental quality and ecosystem productivity should be acknowledged in the planning process, and development projects should seek to adapt economic activity to this major feature of the Amur-Heilong ecosystem.

5. The comprehensive network of protected areas should be established as preventive measure to support biodiversity and ecosystem services of the river under the conditions of accelerating development and climate change.

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