Amur – Heilong River Basin Reader

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Part one: Natural Setting of the Amur-Heilong river basin, chapters 1-3

The Amur-Heilong River Basin

The Amur-Heilong is the largest river basin in northeast Asia. It flows eastwards from the Mongolian Plateau through 13 provinces of Mongolia, China, and Russia and covers a tiny bit on North Korea at Songhua River headwaters. (look map -Amur-Heilong on the Globe). The Amur-Heilong River is one of the world's largest free-flowing rivers at approximately 4,444 kilometers in length and its watershed exceeds 2 million square kilometers. The river forms the border between China and Russia for over 3,000 km, making it one of the world's longest border rivers.

Amur-Heilong River basin is largely mountainous. Mountain ranges, ridges, foothills, and plateaus cover two-thirds of the region. Henty, Great Hinggan, Stanovoy, Tukuringra, Bureinsky, Sikhote-Alin, Changbaishan, Small Hinggan are principal mountain ranges of the area. Most mountains are low and covered with forest, ranging from 300 to 1,000 meters in elevation. Only isolated mountain ranges and peaks, covering just over seven percent of the territory, reach elevations exceeding 2,000 meters. The area covered by plains is also large. Extensive, hilly Daurian Steppe plateau occupies the south-west part of the basin in Mongolia, Russia, and Inner Mongolia. The main plains and lowlands are located between the Zeya and Bureya Rivers, near Khanka Lake, in the valley of the Lower Amur, at the confluence of the Amur-Heilong with Songhua and Ussuri Rivers (Sanjiang Plain), and in the middle reaches of the Songhua at the confluence of the Nen and Second Songhua Rivers, which drain the Song-Nen Plain.

The basin is rich in biological diversity and supports thousands of species and many ecosystem types. This vast area is famous for rare cranes and storks, tigers and leopards, and endemic fishes. The biological richness is explained by a great diversity of landscapes such as floodplain wetlands, steppe, alpine tundra, mixed broadleaf-coniferous forest, and boreal taiga. Approximately 10% of the basin territory is covered by protected areas, and some are nominated as Ramsar wetlands, UNESCO biosphere reserves, World heritage sites, etc. Despite uniqueness and grandeur of many natural areas they are little known by outside world and have not become international tourism attractions. So far national nature conservation programs and international environmental agreements and efforts are insufficient and cannot prevent rapid deterioration of environment and biodiversity loss in Amur basin.

Degree of human impact on the environment in Amur River basin is uneven, but already quite substantial in all countries. Plains support extensive agriculture, especially in China, while other dominant land-use types are extraction of mineral resources, and forestry. Development of international trade spurs construction of transportation infrastructure, oil&gas pipelines. Several major tributaries are alredy blocked by hydropower dams, while lower reaches are severely affected by water pollution from industry and agriculture. Excessive harvest of biological resources: timber, fish, terrestrial wildlife is also triggered by international market demand. Poor land-management practices and accelerating climate change lead to widespread wildfires and land degradation.

Amur-Heilong River basin exemplifies transboundary regions in need of shared environmental responsibility. Land-use patterns and cultural traditions and pace of economic development are drastically different in Russia, Mongolia and China, but sustainable development requires cooperation in the field of environmental protection and nature resource management

Amur Climate

Situated on the eastern rim of Eurasia and abutting the Pacific Ocean, the basin is subject to the combined effects of monsoon climate conditions, oceanic currents, and mountains that direct air circulation patterns. The eastern Amur-Heilong basin has a humid monsoon temperate climate and is an area where monsoons reach their northernmost latitude on earth. The western basin (upper reach of the Amur-Heilong River) is sheltered from monsoon influence by mountains and is arid.

Mean annual temperature varies from -7B° C in the north to +6B° C in the south of Amur River Basin. Annual precipitation varies from bare 250 mm in the westernmost Argun River watershed in Dauria to well over 800 mm in Lower Amur and Ussury River valley.

Nearly two thirds of the basin's precipitation falls in the three months from June to August. May and September are transitional months and the dry season extends for seven months, from October until April during which precipitation is only 15% of the annual total. Floods occur annually during the short three-month wet season, a period during which 84% of the big storms occur. Even so, water is in short supply throughout most of the basin during the much longer dry season and droughts are especially long and severe in south-western part of the basin.

Floods are one of the most important natural processes and determine, in part, the diversity and productivity of the Amur-Heilong 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.

Population dynamics and migration patterns of many species are closely linked to flood and drought cycles, as demonstrated for stork, cranes, bustard, and even musk deer.

Global climate change is quite obvious, especially in western part of the basin during last 100 years. Temperatures in the eastern Amur-Heilong basin have risen 0.60C , while, in the central and western basins, increases have reached +1.70C at Blagoveshensk and even more in Chitinskaya Province. Ecosystems in the basin are vulnerable to any abrupt changes and are already actively evolving in response to modified climate patterns. Human activities are also changing in response to natural shifts.

Precipitation

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Snow cover is only 1-21 cm thick in the Mongolia basin, allowing for year-round livestock grazing. During the warm season, 247 mm or 94% of annual precipitation falls as rain, while almost 14 mm or 6% of total precipitation falls as snow in the cold season. Local climatic variations here are extreme and this promotes diverse vegetation types from semi-desert to taiga forest. Downstream, but yet in the upper Amur-Heilong, precipitation ranges from 400-500 mm. Total precipitation in the middle reaches of the Amur-Heilong increases to 500-700 mm. Annual precipitation on the continental plains of the China basin is 450-600 mm. Snowfall is modest and snow cover rarely exceeds 20 cm. The shallow snow cover allows soils to freeze to depths of 2-4 meters. Most snow sublimates before spring melt due to the dry atmosphere and intense solar radiation. In humid areas of the Lower Amur-Heilong and Ussuri-Wusuli Rivers precipitation is abundant, exceeding 700-800 mm. Although typhoons are infrequent, they can bring rains of up to 400 mm in a single day. Rainfall accounts for 60-75% of annual precipitation, starting from 20 May to early June in all parts of the region, and ending during the last ten days of September. The lower Amur and Okhotsk seacoast are among the most snow-rich areas of the world, with 1-2 meters of snow cover by the end of winter. Some valleys accumulate 3-4 meters.

Climatic fluctuations: Floods and Draughts

Water flow in the Amur-Heilong basin varies widely between seasons and years. At Komsomolsk City on the lower Amur average annual flow is 10,900 m^3/sec. Maximum flow is

37,900 m^3/sec and minimum recorded flow is just 345 m^3/sec, less than 1% of the maximum. In Russia it is believed that large floods occur once every 11-13 years in the middle Amur. Summer monsoon rains occur across most of the basin and cause the floods that are common in most Amur-Heilong basin rivers. Floods are one of the most important natural processes and determine, in part, the diversity and productivity of the Amur-Heilong 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.

Water levels in the upper and middle reaches of the basin vary over a range of 10-14 m during the year. In the lower Amur, the water level range is 6-7 m. On average there are 4-6 floods each year, increasing to 6-9 on small rivers. During floods the water surface of the lower and middle Amur-Heilong may expand to widths of 10-25 km. Waters often remain on the floodplain for extended periods.

Flooding is considered not only one of the most important ecological characteristics of the Songhua River basin; it is also the most important economic problem. Floods recur regularly on the Nen and Songhua plains and are the primary agent that shaped the plains and that led to the creation of its extensive wetlands. Several million hectares of the largest inland freshwater wetlands of China are located on the Song-Nen plain and on the Sanjiang plain

In June to August 1998, the most severe flooding on record in the Nen and Songhua River basins was caused by simultaneous monsoon rainfall in the headwaters of both rivers. Floods of this magnitude are estimated to recur on the average of only once in 150 years. The 1998 flood created lakes larger than 8,000 km^2 in Jilin and Heilongjiang Provinces. More than 7.54 million people were relocated to higher ground, some of whom were still waiting 6 months later for waters to recede before they could return to their homes and villages. Water-logging lasted for two years on some parts of the flood plain.

A total of 154 people lost their lives during the 1998 floods. The 1998 floods affected most of the Song-Nen plain in eastern Inner Mongolia Autonomous Region (IMAR), western Heilongjiang Province, and northern Jilin Province. Damage costs were estimated at $1.8 billion, $3.6 billion, and $1.7 billion, respectively. The floods caused incomes of 1.8 million people in the three provinces to fall below the government poverty threshold. The floods disrupted social and economic activities of some 16.1 million people. There was extensive damage to houses, crops, livestock, fish farms, commercial premises, and infrastructure including roads, bridges, railways, power transmission, irrigation systems, water storage and reticulation, sewerage reticulation, drainage systems, and flood protection facilities. Floods damaged over 937,000 hectares of farmland, 2,600,000 hectares of grasslands, 89,000 hectares of fish ponds and 126 water reservoirs (Beach 1999).

The 1998 floods together with similar events in the Yangzi, Liao and other river basins pushed Chinese water management authorities to rethink the paradigm of "flood prevention" and to shift from engineering approaches toward adaptation to natural processes.

Climatic fluctuations often show cyclical patterns within short timeframe . The most obvious example of this is the cyclical pattern of water-abundant and water-deficit periods in Amur-Heilong River flow data at Khabarovsk. During the past 110 years, full cycles can be observed in the periods of 1924-1944, 1936-1955, and 1955-197. Water-abundant periods occurred in 1896-1916, 1926-1943, 1955-1966, while water-deficit periods were 1917-1927, 1967-1980.

Amur River System

Amur is one of largest rivers of the world some 4,5 thousand kilometers long. At approximately two million square kilometers, it is also the world's eleventh largest watershed

The Upper Amur-Heilong Basin includes the Mongolian headwaters and Argun/Erguna River basin, the main stem of which flows for more than 900 kilometers and forms the China-Russia border. Western part of the basin has thousands shallow steppe lakes, which fill and dry in the course of drought cycle.

The main stem of the Amur-Heilong River proper that flows to the east from Great HingganMountains is often referred to as a river of three reaches, Upper, Middle, and Lower. The Upper and Middle Amur are shared by Russia and China. The Lower Amur lies completely within Russia and stretches 947 km from the mouth of the Ussuri River to the estuary of the Amur-Heilong River emptying into Tartar Straits. The largest tributaries of the Amur-Heilong River are the Zeya (Russia), Bureya (Russia), Amgun (Russia), Songhua (China), and Ussuri/Wusuli (China, Russia). The Upper and Middle Amur and lower reaches of all tributaries have wide well-developed floodplains with numerous floodplain lakes connected to main river channels.

Main channel of the Amur River proper so far has no dams and reservoirs, among main tributaries only Zeya, Bureya and Songhua rivers are obstructed by dams.

The Amur River average annual discharge into the Pacific is 364 km^3 (Makhinov 2005) and this enormous flow (equal to 77% of the Mekong River and 7 times greater than the Yellow River) carries 15-24 million tons of sediments, for an average of 55 g of sediment per m^3 of water. On first impression the Amur-Heilong seems quite clear, despite considerable water pollution and other human impacts. The average sediment load in the Amur-Heilong is similar to that of the Congo (heavily forested) or the Columbia River (intensively dammed), but is only 0.15% of the average sediment load in the world's most sediment-laden river, China's Yellow River (36 kg/m^3).

Despite large discharge at the river mouth, many parts of Amur River basin are water-deficient drought-prone areas, and southern part of the basin is subject to very intensive water management and water infrastructure development. Water resources are limited and their sustainable use depends on cooperation between three basin countries.

Since basin is divided between countries this river system is not sufficiently studied even by hydrologists. No agreement is reached among experts regarding the exact size of the Amur basin. The western and southwestern reaches of the basin in China and Mongolia have numerous endorheic rivers, rivers that drain into closed inland wetlands or lakes, rather than into the main river system. Other partly endorheic basins drain into the Amur-Heilong only in wet years and some have stopped flowing entirely due to human water consumption. For these reasons, authors estimate the total watershed area differently. The most common estimates of the basin's area are 1.86 million km^2 in official Russian sources (Surface water resources of the USSR. Hydrology. 1966), and 1.93 million in many international sources (IUCN/WRI World Watersheds eAtlas 2005). We consider Kherlen, Khalkh, and Uldz Rivers and some other closed basins to be important intrinsic components of the Amur-Heilong basin ecosystem(see map). When considering these headwaters, the estimated basin area is at least 2,129,700 km^2.

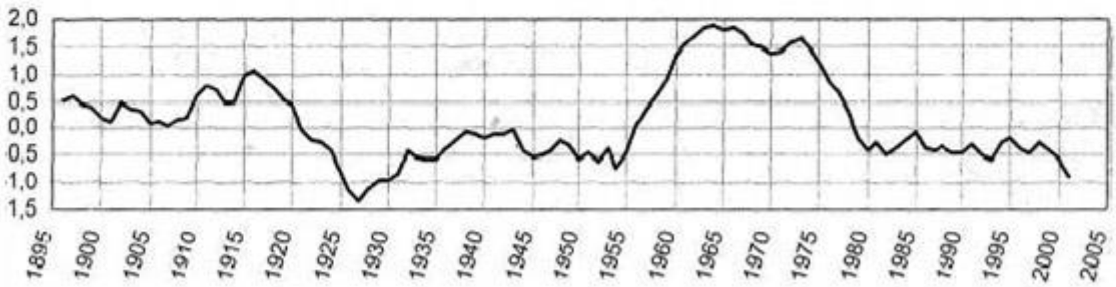

Figure: Volume of Amur-Heilong River flow at Khabarovsk hydrological station 1895-2001 (Novorotsky 2002)

A more complicated pattern of precipitation cycles has been observed in the area extending from eastern Mongolia to Lake Khanka. Small, 9-12 year cycles coincide with the intensity of solar radiation, while more pronounced 20-25 year cycles resulted in minimum precipitation in the beginning of the 20th Century, in the 1920s, mid-1950s, late 1970s, and the early 21st Century. While the tendency is uniform for the Amur-Heilong basin, the onset of some drought periods may be delayed for 2-3 years. Eastern monsoon regions enter drought periods later and return to wet periods earlier than western locations such as Chita, Mongolia, and Inner Mongolia. B In western part of the basin where huge wetlands and lakes such as Dalai or Torey regularly dry up once in several decades the role of draught cycle in local ecosystem process is especially obvious and impressive.

Population dynamics and migration patterns of many species are closely linked to these cycles, as demonstrated for cranes, stork, bustard, and even musk deer.

It has been calculated that in China economic loss from draughts is much greater than from floods. Draught effects are prolonged over time and thus are less noticeable than floods, which are viewed as natural catastrophes. Both types of losses demonstrate that human economic development has failed to adapt to climate patterns peculiar to the region. B Inefficient, high-levels of water consumption that are possible in wet periods cannot be sustained in times of draught without severely dropping water levels in wetlands and streams. B Development of floodplains occurs during draught periods, buildings and infrastructure that are then destined to be damaged by next flood.