



Flood in the Amur basin © Hartmut Jungius / WWF

WE AND THE AMUR FLOODS: LESSONS (UN)LEARNED?

REPORT SUMMARY AND CONCLUSIONS

*by Eugene Simonov, Oxana Nikitina, Peter Osipov, Evgeny Egidarev and
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REPORT SUMMARY AND CONCLUSIONS

The findings and conclusions of the report “We and the Amur Floods: Lessons (Un)Learned?” are summarized in the following short text. The conclusions are drawn from the Russian version of this report and some of them reflect issues not fully described in the abridged English version.

The topic for this report was initially presented to the *UNECE Programme of pilot projects on adaptation to climate change in transboundary basins* in late 2015. It was selected because of the great flood that took place along the transboundary Amur River in the summer and autumn of 2013. The topic serves to explore feasible options for the integrated flood management jointly implemented by Russia and China.

- I. River floods occur mostly due to natural environmental phenomena. The level of hazard depends primarily on the rise of the water level in the river. Floods can cause huge social and economic damage in densely populated areas in river valleys, especially in floodplains.

According to the Integrated Flood Management Concept, it is critical not only to identify the flood risk by characterizing the hazard (the magnitude of the flood hazard expressed in terms of frequency and severity), but also to assess the exposure of human activities to flooding and the vulnerability of the element at risk. An area with a high probability of flooding but without any infrastructure and population enjoys a very low level of the flood risk, because its vulnerability is close to zero.

Flood damages have steadily increased worldwide through the several recent decades. Nowadays, humankind is not sufficiently adapted to existing hydro-meteorological phenomena, let alone possible future climate change. Even in the absence of increased flood hazard owing to increased heavy precipitation or other modifications of the climate system, flood risk will generally increase as exposure is rising. Over time, population has increased in most flood-prone areas, and the accumulation of assets has increased exposure to loss.



**Flood-affected house near the Ussuri/Wusuli River in China
by Rivers without Boundaries Coalition**

In Russia, losses resulting from floods are aggravated not only by the aforementioned development in floodplain areas, but also by the following circumstances:

- Sharp reduction in the number of hydrometric stations on Russian rivers during the last 25 years;
- Lack of an efficient information system capable of notifying the population about flood threats, along with certain ill-preparedness of local residents to take adequate action;
- Inadequate legislation on property insurance and flood-damage compensation in flood-prone areas that creates incentives for inappropriate floodplain development.

Riverine aquatic ecosystems (among them rivers, wetlands and estuaries) provide such benefits as drinking water, food, materials, water purification, flood mitigation and recreational opportunities. Variability in flow quantity, timing and duration is critical to the maintenance of river ecosystems. For example, flooding serves to maintain fish spawning areas, help fish migration and flush debris, sediment and salt.

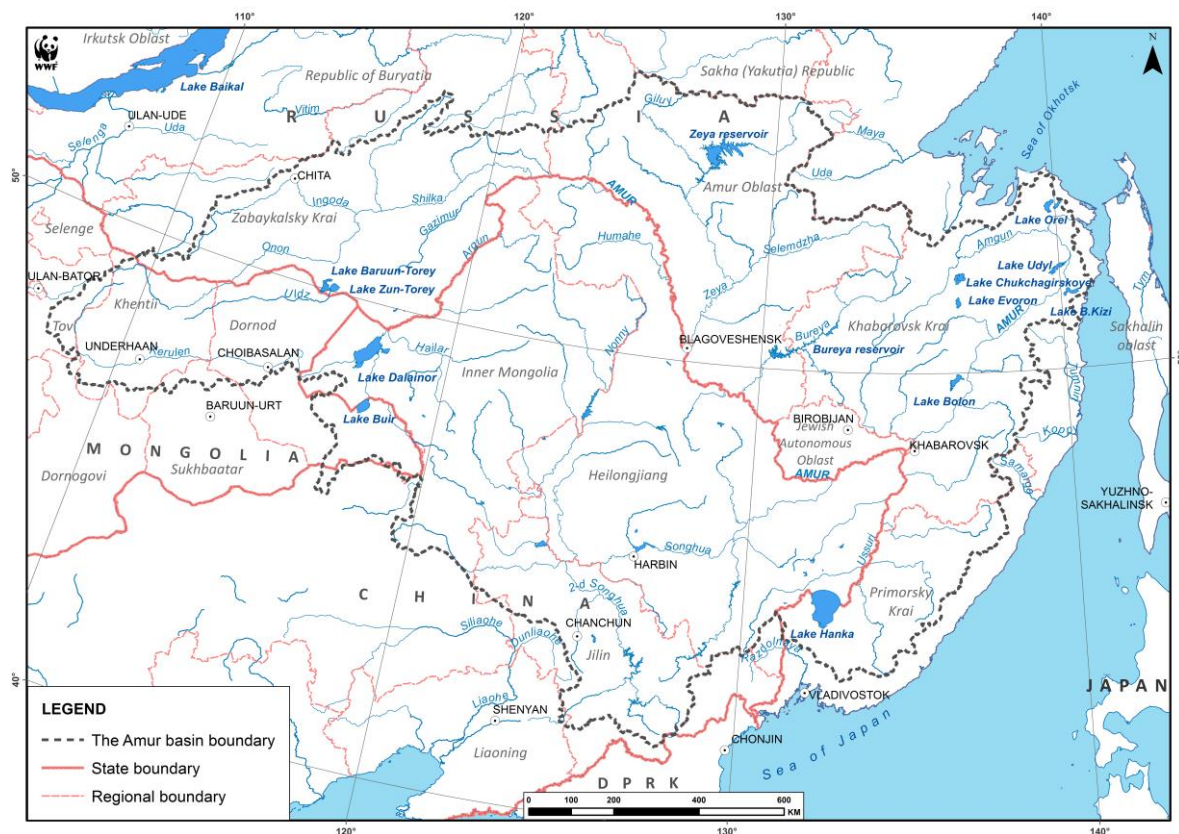
It is a universally accepted fact that rivers with natural unaffected floodplains have a higher ability to retain water during high floods and prevent flood damage than those flowing in more developed floodplain areas. Having a floodplain water retention capacity contributes to reducing discharges along the river bed and decreasing the speed of the maximum flows. *(For more see Chapters I and VII of the Report.)*



The Argun River floodplain
by Oleg Goroshko

- II. The most catastrophic flood during the whole period of observation took place in the Amur basin in July to September 2013, lasting for about two months. It shed light on many characteristics of the natural processes in the basin, as well as the land, water and dam management issues. The flood management was further complicated by the transboundary location of the basin.

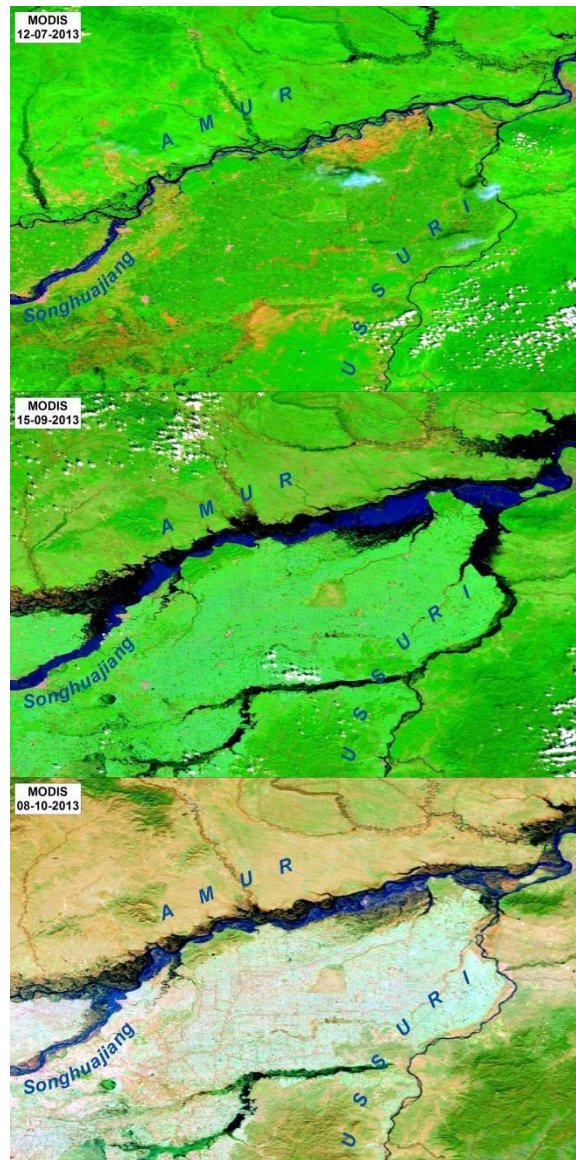
The Amur River (Heilongjiang in Chinese) is formed by the confluence of the rivers Shilka and Argun; it flows into the Sakhalin Bay of the Sea of Okhotsk. The length of the river from the confluence is 2,800 kilometers, the catchment area is 1.85 million square kilometers (2.1 million square kilometers counting the periodically closed basin of Lake Dalai). The Amur is a transboundary river: the Russian-Chinese border goes along the rivers Argun, Amur, Ussuri, Tur, Turga and Sungacha for more than 3,500 kilometers. The Amur basin is shared by four countries: Russia, China, Mongolia and North Korea. The Amur's hydrological regime is characterized by uneven seasonal and annual flow. Pronounced summer floods are typical for the Far Eastern regime, accounting for 75–80% of the annual flow.



The Amur River basin by Amur branch of WWF-Russia

The flood of 2013 affected almost the whole basin including the Russian Far East and the north-eastern Chinese region. Peak water levels in the Middle and Lower Amur exceeded previous all-time highs by 0.4–2.1 m. Near the cities of Khabarovsk and Komsomolsk the water had remained high for over a month, while the floodplain had remained flooded for over two months. At the peak of the flood the highest discharge near Khabarovsk was measured at 46,000 cubic meters per second; the recurrence of such events was estimated to be about once every 200–250 years.

According to the official data, the flood negatively affected 366 settlements with a population of 170,000 people located in the Russian section of the Amur basin as well as 6000 square kilometers of agricultural land, numerous highways, bridges and power lines. Khabarovsk and Komsomolsk cities were seriously flooded (see figure below). During the 2013 flood, 13,000 residential buildings were waterlogged, with 2,400 of those damaged beyond repair in the Russian part of the Amur River basin.



**Middle Amur before, during and after the 2013 flood
MODIS imagery by NASA**

Notwithstanding the relatively efficient management of emergency situations, the 2013 flood has demonstrated deficiencies in overall flood management policies and practices in Russia. Since the 1990s the Russian government has declared it a necessity to undertake zoning of flood-prone areas, issue appropriate regulations for use of floodplains and support flood-related insurance schemes. None of these promises have been fulfilled, and the responsible agencies still primarily support excessively costly engineering measures aimed at quite hopelessly fighting the natural flooding processes in riverine ecosystems.

In July 2014, the Russian Minister of Natural Resources presented the “Integrated system of measures on reducing risks of floods in the Far Eastern Federal District”, consisting predominantly of structural measures:

- Increasing accuracy of forecasting meteorological and hydrological phenomena;
- Increasing flood-prevention capacities of water storage reservoirs’ (including construction of new “anti-flood” hydropower dams);
- Reducing risk of floods by increasing river conveyance (by dredging) at specific sections;
- Protecting settlements and infrastructure with engineering structures (mostly by dykes);
- Preparing protective hydraulic facilities, communal and transport infrastructure for accident-free passage of flood waters;
- Preparing local and functional subsystems of the Russian emergency management system for taking adequate action during emergencies.

Obviously, this list shows that Russian authorities still favor infrastructure over any other risk prevention measures. *(For more see Chapter II of the Report.)*

- III. In China, that has managed floods for 2,000 years longer than Russia, the Integrated Flood Risk Management Plan designed for the Songhuajiang basin works well enough on the whole, with all key objectives met in 2013. During the flood, emergencies involving dike failures which flooded villages and blocked major highways happened practically in all counties along the Amur River. Damages in the Chinese portion of the basin were much higher than those in Russia due to there being a much greater exposure of population and assets to flood hazards.

Flood management measures taken by China along the Amur River leave much to be desired. Regarding the border rivers, most of the environmentally or economically unjustified steps are usually taken not so much to protect the economy from floods but to minimize “the loss of national territory” due to natural riverbed dynamic processes. The construction of dykes cutting off the floodplains creates a potential risk of increased water levels and emergence of dangerous floods under discharges which previously resulted only in non-catastrophic floods. Disastrous dike failures occurred in counties Jiayin, Luobei and Tongjiang, thus resulting in flooding of large populated areas. If the Russian bank had been protected by an unbroken line of giant dykes too the water level would have risen much higher and damages would have quadrupled.



Three disastrous dike failures on Chinese maps and Russian flood modeling data
by Wenbin Liu

A comparison shows that flood management efforts in the Songhuajiang basin were much more efficient than those along the Amur's main channel in 2013. An obvious reason is that designing a joint integrated flood risk management plan with the Russian side was deemed impossible (or hopelessly difficult). Another clear reason is that developing territories along the Amur's main channel is currently less economically important to the PRC compared to the densely populated Songhuajiang banks.

The population on the Russian side is at least 10 times smaller and floodplains are much less encroached upon by development, which explains the drastic difference in the damages on the neighboring river banks. On the whole, the Chinese authorities don't consider the 2013 flood that caused direct losses of 3–5 billion dollars a major disaster. Or at least it has not convinced them to reconsider their policy on managing the Amur basin water resources.



Construction of a new dyke along the transboundary Ussuri/Wusuli River in 2014
by Rivers without Boundaries Coalition

Still, multiple dyke failures along the Amur River have prompted emergence of new engineering protection projects. Over the next 3 years, 24.6 billion yuan (4 billion dollars) will be invested in construction and reinforcement of dykes on the rivers Heilongjiang (Amur), Songhuajiang (Sungari) and Nenjiang, with a total planned length of 2,722 kilometers. This construction also serves to boost local employment and support cement, steel and other industries currently experiencing overcapacity in China. *(For more see Chapter III of the Report.)*

- IV. Notwithstanding the rather short-sighted unilateral measures following the 2013 flood cooperation on the Amur River basin, flood management is inevitable. China has recently launched the “Silk Road Economic Belt” development initiative that promotes closer integration between all countries of Eurasia and shifting some of the domestic industrial overcapacity to other resource-rich countries within the region. This change necessitates adjustments in the transboundary water policies, because for China it is now also important to ensure that the water resources of its neighbors are managed well and are sufficient to support jointly pursued economic development plans.

There are numerous reasons why understanding and influencing flood management in Russia is critically important to the PRC. Among others, they include the following:

- A. The Amur-Heilongjiang basin is the third largest in China. It is the leader in grain production and a foundation for economic development. Due to specific features associated with a river border, managing this basin is only possible in close coordination with the Russian side. China needs to adequately monitor and manage this process and flood risk management constitutes a crucial element.
- B. The Chinese side has certain reservations regarding the safety of Russian hydraulic facilities (especially two hydropower plants) during floods and numerous other changes taking place along the Amur’s trunk due to construction of hydropower plants on its tributaries. On the other hand, the same giant water storage reservoirs can be used for flood management, which has potential benefits for the PRC too.
- C. “Protecting the motherland’s banks” – i.e. maintaining the national border and stretching it towards Russia – has been a steadfast Chinese policy in the Argun – Amur – Ussuri area for many decades. Floods are major factors which can help or hinder implementation of this policy.



**The Amazar pulp-mill dam is the first reservoir financed and built by the Chinese in the Russian part of the Amur basin
by Igor Shkradyuk**

- D. Protecting biodiversity and wetlands in the Amur basin is a major component of Chinese environmental policy. China's wetlands are degrading nationwide at an amazing speed, causing concerns at the highest policy level. The Amur River basin has the largest protected wetland area, over 3 million ha, which is largely sustained by the natural flood regime.

Under these conditions, even if the Chinese didn't see the 2013 flood as something extraordinary, the PRC decided to use the opportunity to increase cooperation in many areas and develop a system for managing the common river basin. Therefore in early 2014, the Sino-Russian Transboundary Water Joint Commission commissioned a bilateral research effort that in a year resulted in a Joint Report on the 2013 flood on the Amur River. Although it was very limited in its contents covering only hydrometeorology and river-bed processes, the Joint Report still represents a serious achievement in bilateral information sharing and analysis in flood management and the fact that it was produced in English makes it possible to share it with a wider international audience.

The 2013 experience can serve as a starting point for developing a joint flood risk management program based on better-quality forecasting, land use regulation in floodplains, protection of floodplain wetlands and coordination of flood protection structures' construction. Considering this, one should clearly understand that the situation in China and Russia and their respective interests may differ significantly, so not every joint "flood management" program would benefit both countries equally. However, an integrated program aimed primarily at a more efficient adaptation of economic activities and settlement planning to the Amur's cyclic hydrological fluctuations and maintaining productivity and diversity of the common river ecosystem, would certainly benefit both nations greatly. So this should be the basis for any approach to planning the Amur River basin flood risk management. *(For more see Chapter IV of the Report.)*

V. Summary of our recommendations for integrated flood management in the transboundary Amur River basin

A. Integrated flood management planning

The "Integrated Flood Risk Management System" currently developed in the Amur River basin consists primarily of engineering measures and cannot provide adequate adaptation of economy and population to periodic floods. To ensure sustainable operation of the economic infrastructure and suitable living conditions an efficient Flood Risk Management Plan should be an integrated one, so it would be possible to compare potential economic efficiency of various measures to minimize the risks and adapt the socio-economic systems to the local environmental conditions in each specific area. This would also give a chance to improve living and economic conditions in the Amur basin.

- a. In the course of developing an Integrated Flood Management Plan, various sets of flood management measures should be evaluated in terms of their cost efficiency, social

acceptability and environmental safety. Naturally, these steps should meet the established standards for planning, construction, etc. Cost-benefit analysis, multi-criterion analysis and strategic environmental assessment are typically used for comprehensive evaluation and optimization of such plans. Currently Russian Comprehensive Schemes for Water Bodies Management and Protection that include flood-management measures do not incorporate practically any the aforementioned features and should be reformed to meet basic requirements for modern IFM and IWRM.

- b. An integrated flood management plan should address the following five key elements that would seem to follow logically for managing floods in the context of an Integrated Water Resource Management approach:
 - i. Manage the water cycle and river-basins as a whole;
 - ii. Integrate land and water management;
 - iii. Adopt a best mix of strategies;
 - iv. Ensure a participatory approach;
 - v. Adopt integrated risk management approaches.

Source control to reduce runoff	<ul style="list-style-type: none"> • permeable pavements, • afforestation • artificial recharge
Storage of runoff	<ul style="list-style-type: none"> • wetlands • detention basins • reservoirs
Capacity enhancement of rivers	<ul style="list-style-type: none"> • bypass channels • channel deepening or widening
Separation of rivers and populations	<ul style="list-style-type: none"> • landuse control • dikes • flood proofing, zoning, house raising • flood warnings
Emergency management during floods	<ul style="list-style-type: none"> • emergency works to raise or strengthen dike • flood proofing • evacuation
Flood recovery	<ul style="list-style-type: none"> • counselling • compensation or insurance

Variety of flood management strategies/interventions ¹

- c. Climate adaptation is among the central objectives of the IFM. In many developed countries flood and drought management (due to the growing risks of both these phenomena) is also increasingly seen as two components of the same climatic adaptation program. In China the relevant government agency is responsible for managing both floods and droughts. A major aspect of developing a flood management strategy is about taking into account climatic fluctuations, the directions and expected

¹ Integrated Flood Management Concept – Geneva: WMO, 2004.
http://www.apfm.info/publications/concept_paper_e.pdf

scale of climate change and the level of uncertainty associated with it. The following aspects should be taken into consideration:

- i. Adaptation to shorter-term known climatic fluctuations is the first necessary step to reduce vulnerability to possible longer-term climate change;
 - ii. Developing a special plan solely devoted to reducing flood risks, independent of meeting other water resource management and nature protection challenges wouldn't be practical. So it should be developed in conjunction with IWRM plans, spatial planning and regional nature conservation programs;
 - iii. Adaptation programs should be based on a solid scientific foundation and good-quality survey and monitoring data;
 - iv. Adaptation planning is quite meaningless without wide continuous participation of all those entities that will have to adapt to floods and droughts.
- d. The Methodology for Flood Damage Assessment currently used in Russia should be revised and improved. Calculated damages often exceeded the known compensations or de-facto losses in the 2013 flood by an order of magnitude. Very often annual average flood damage calculated according to this Methodology exceeds the damage we actually observed in the catastrophic 2013 flood.
- e. The Methodology for Assessment of Flood Protection Measures Efficiency also requires major correction. As it stands now the Methodology can help justify high economic gains resulting from any obviously inefficient engineering structures. Sometimes it shows that construction costs of colossal engineering project are recovered in several weeks or even days. Without adequate assessment tools it is impossible to conduct flood management planning.
- f. Strategic environmental assessment is an essential tool in IFM planning. The objective of a strategic environmental assessment is to ensure a sufficiently high level of environment protection. This is achieved by a thorough consideration of environmental aspects, including health-related ones when plans and programs are designed. It should be based on clear, open and efficient evaluation procedures, with participation from various stakeholders. If necessary, strategic environmental assessment (SEA) may include analysis of economic and social issues. The key SEA principles should be: public participation, transparency and high quality data.
- g. The SEA tool is not commonly used in Russia yet. However, the "Basic Government Policy on Environmental Development of the Russian Federation Until 2030" approved in 2012, sets an objective of adopting legislation to promote and conduct strategic environmental assessment in the course of plans' and programs' development. To implement that, Russia should ratify the Espoo Convention and its Protocol on SEA as soon as possible. Experience with SKIOVO shows that EIA is not an adequate tool for assessing such complex programs and SEA should be routinely used for this purpose. *(For more see Chapter V of the Report.)*

B. Engineering measures for flood control

Engineering (or structural) measures should be cautiously viewed as an inevitably expensive tool used to protect high-value assets, mostly cities and large rural settlements.



**Construction of Bureyskaya Dam
by WWF-Russia**

Flood control reservoirs

There are several factors that limit development of hydropower in the Amur River basin in Russia:

- i. Well known negative consequences from the construction and exploitation of the two already existing power plants on the Zeya and Bureya rivers;
- ii. Lack of demand for additional electricity generation in the region for the foreseeable future;
- iii. Little economic benefit from construction and functioning of hydropower for the local population of the region;
- iv. High construction costs compared to other options.

Since the disastrous 2013 flood the Russian President and the Government have issued instructions to develop the flow regulation system in the Amur basin. In line with the government instruction, a list comprising 8–10 potential “anti-flood” hydropower plants had been drafted by the beginning of 2014.

However, the Amur basin no longer has large undeveloped tributaries with suitable orographic and hydrographic conditions. Any new water storage reservoir would have a much lower water

accumulation potential, due to the lack of large enough regulating volumes in the upper stretches of the rivers. Investing more than 400 billion Russian rubles (in May 2015 prices) in several hydropower plant projects to manage floods may fail to produce the expected flood risk reduction effect, so it doesn't seem economically viable.

From the ecological point of view, building any major new water storage reservoir significantly damages the environment. The scale of the damage is determined by many factors, in particular: changing hydrological regime and alluvium runoff; fragmentation of the basin; flooding of lands and transformation of the natural ecosystem dynamics in the areas located upstream and downstream of dams.

Building flood-protection dams and water storage reservoirs cannot entirely solve the problem of catastrophic floods caused by seasonal flooding in years with hydrological extremes. When designing anti-flood hydropower plants, their feasibility should be assessed compared with alternatives, as well as their environmental impacts. But first of all we would recommend comparing the efficiency of regulating flows by building new hydropower reservoirs with that of the protection of flood retention capacities of the natural flood plains. Besides protecting floodplains we also recommend several other alternative measures:

- a. For the Zeya hydropower plant which significantly affects the hydrological regime of the Middle and Lower Amur, the following additional steps should be considered (with relevant feasibility studies): adjust the flow regulation regime (to maintain the water storage reservoir's free accumulating capacity to receive summer flood waters); improve the design (e.g. building a bypass spillway, etc.); fix known engineering deficiencies (e.g. replace dysfunctional gates for water discharge regulation), create economic incentives (introduce charges for reserving flood-storage volume to have a guaranteed opportunity to use a large proportion of reservoir capacity);
- b. Single-function flood-control reservoirs could be used on small and some middle-sized rivers of the Amur River basin where it can significantly reduce flood risks for large settlements;
- c. Other alternative (and often cheaper) solutions include various adaptation measures and promoting insurance coverage against natural disasters.

Construction of dykes and other structural measures

The Comprehensive Scheme for Water Resource Management and Protection in the Amur River basin duly limits areas recommended for protection by dykes only to territory of settlements. In order to protect all settlements from the Amur River flood damages, according to the Scheme, it is necessary to provide protection through dykes less than 300 square kilometers and this would cost around 30 billion rubles (roughly 500 million dollars in 2015). This shows that protection of settlements by dykes is a far less expensive measure when compared to anti-flood hydropower reservoirs. Despite their known limitations, dykes have been and will remain in the foreseeable future the main structural protection measure for settlements in the Amur basin.



**Dyke construction on the Upper Amur River in China
by Rivers without Boundaries Coalition**

The failure of many dykes to protect settlements was due to runoff inundating protected areas from the back. A system of drainage channels transporting rainwater outside from areas protected by dykes should be an indispensable part of any protection scheme.

We recommend the following:

- a. China's mistakes shouldn't be repeated on the Russian side which is populated comparatively sparsely. It is important to avoid building long dikes protecting agricultural lands and small villages with their lengthy front. If built their design should allow for forced controlled flooding during catastrophic floods to be able still use the floodplain water retention capacity fenced by dykes.
- b. The dykes on transboundary watercourses should be designed with the anticipation of a possible reduction of floodplain width on the opposite side.
- c. The villages flooded only rarely should not be subject to protection by dykes. Engineering adaptation to low-recurrence floods would suit such settlements much better.
- d. Dredging is usually an insufficient flood-protection measure on the medium-sized rivers of the Amur basin and should be used only in conjunction with dyke construction.
- e. Dredging projects planned in the Amur River's main stem are very questionable in an economic sense and bear significant poorly studied environmental risks.
- f. Dredging and other measures interfering with riverbed processes may cause significant environmental impact that should always be subject to EIA process.



**The Transsibirskaya Railroad bridge is most likely responsible for a 0.5–0.7 meter rise in the maximum flood levels near Khabarovsk
by Rivers without Boundaries Coalition**

Decommissioning and reconstruction of engineering structures that increase maximum flood levels

In addition to natural factors, economic activities have also played a role in the high rise of water in certain areas of the Amur basin during the 2013 flood – such as long protective dykes (primarily the ones built on the Chinese side), spur dikes, polders, bridges, other linear structures in the Amur valley, wetland reclamation, logging and fires in river basins. It is likely that the total contribution of just Russian hydraulic facilities built in the river valley caused an increase in the peak water level near Khabarovsk by 1 meter or more. Therefore the assessment of possibilities to reduce the impact of those structures on maximum flood levels with subsequent structural improvements removing obstacles is an obvious matter of the highest priority for any future IFM Plan. *(For more see Chapter VI of the Report.)*

C. Adaptation to floods

Adaptation to floods includes: introducing land-use regulations in flood-prone river valley areas; relocating populations to safe areas; gradual removal of housing and businesses unprotected by hydraulic facilities from regularly flooded areas and adapting the remaining communities and structures to periodic flood impacts.

Right after the 2013 flood, the Russian national authorities made amendments to the relevant laws in order to avoid the heavy flood damage resulting from the development of river valleys and particularly floodplains. New legislation prohibited construction of any permanent buildings in flood-prone areas, unless protected by special engineering measures. However it

left unanswered the question of what should be done with the buildings already existing in floodplains.

Subordinate Governmental Decree prescribes delineation of 7 zones with flood recurrence of 1, 3, 5, 10, 25 and 100 years as well as zones with 3 different degrees of water logging by groundwater. It was no surprise that by the end of 2015 not a single Russian province in the Amur basin had completed delineation of flood-prone zones and completion of this work is scheduled for 2021–2023. Therefore the legal base for lawful limitation of construction in floodplains has not been completed and the rampant construction of housing in floodplains goes on.

We recommend the following:

- a. Flood prone area zoning should be implemented in two stages. At first, right after a catastrophic flood, it would be sufficient to develop a flood-hazard map showing the boundary of actual flooding in 2013. Quickly integrated into zoning regulations, such a map would help to prevent further development of flood-prone areas in the short term which will help buy time for a more laborious zoning exercise.
- b. The following principles should be applied to regulating economic activities in flood-prone areas:
 - i. The number of flood-prone zones authorized for regulated economic activities should be small;
 - ii. The norms and rules for residential planning and development should be based on assessment of not just economic risks, but also risks to human life;
 - iii. The criteria applied to establish the borders of high-risk zones should be clear to the owners and users of the land and properties and to the public authorities.
- c. Extensive information about traditional and modern ways to adapt settlements to periodic flooding has been collected, published and made available in dozens of countries – but unfortunately not in Russia. The Amur basin's harsh climate somewhat complicates the matter by creating additional requirements to adapting buildings in terms of frost penetration and ice corrosion. The biggest problem for the people who used to live in the houses flooded in the summer of 2013 was that the period between the ebb of the flood and the first frosts was too short, so there wasn't enough time for their homes to dry up. Public authorities should commission the development of relevant construction standards and regulations to upgrade the settlements which cannot be relocated when the diking is either unreliable or uneconomical.
- d. Many floodplain soils are highly fertile and allow (between floods) the achievement of crop yields much higher than average. Agricultural areas should be subject to special flood-risk zoning and special insurance policies. An adequate adjustment of agricultural activities requires various steps depending on the specific risk zone.

- e. Small indigenous communities, fishing companies and agricultural enterprises in the floodplains should consider possible ways to better adapt the local economy to high-water phases of the climatic cycle, based on the increase in highly productive schools of common fish thriving during floods. *(For more see Chapter VI of the Report.)*



A new house in the village of Belgo, which was fully rebuilt in September 2014 by dvnovosti.ru

D. Incentives for the local population

Throughout history, the Russian government has created incentives for citizens to encroach on floodplains. For example in the Soviet times, thousands of land plots for “gardening cooperatives” (*dacha*) had been allocated in flood-prone areas around Khabarovsk, Blagoveshchensk, Komsomolsk and other cities. Currently, the floodplains’ urbanization rate grows due to the construction of expensive country houses on these land plots. People often invest a considerable proportion of their savings in their country houses, so losing them is quite painful for the owners. During the 2013 flood, most of the houses destroyed by water belonged to this category.

In 2013, the state demonstrated paternalistic willingness to pay for mistakes made by its citizens, thus proliferating floodplain development. For example, all those whose houses had been destroyed by the flood were both given free housing in flood-safe areas as compensation and not obliged to hand over their old houses in the floodplains for demolition. Furthermore, depending on the flood damage and the quality of the house, one of two houses standing next to each other could be declared destroyed by the flood, while the other deemed only to be requiring cosmetic repairs. So settlements persisted even in the most risky flood-prone zones. Only 2–3% of affected houses had flood insurance and this proportion is not likely to have risen since the 2013 flood.

The following measures may improve the situation:

- a. Information on possible adaptation measures, technologies and practices and consequences of neglecting them should be widely disseminated among local stakeholders with reference to specific conditions of their settlements/districts.
- b. The Government should stop compensations to owners of houses in flood-prone zones which were built illegally.
- c. Insurance rates and policies should be widely differentiated depending on flood-risk zone, which necessitates development of flood risk maps. Otherwise insurance companies will not be able to cover flood risks.
- d. Local self-government bodies should be incentivized to engage in adaptation of the infrastructure in their settlements to flood risks. *(For more see Chapter VI of the Report.)*

E. Improving flood forecasting systems

Russian hydro-meteorological services are plagued with an insufficient number of field personnel, inadequate equipment, low pay and poor social benefits as well as limited free-of-charge access to the monitoring data. Without solving those problems efficient planning of any kind of flood management hardly seems possible.

Given the insufficient funding and poor availability of equipment, the timely short-term forecasts of very heavy cloudbursts and high rain-induced floods issued by the Russian Hydrometeorological Agency (Roshydromet) during the 2013 flood were nothing short of a miracle. These forecasts allowed the public authorities to start working on the evacuation of residents, protection of residential areas and critical infrastructure of the region in time.



**A local observer equipped with a level-measurement ruler
by Sergei Shapkhaev**

However, the available methodological framework for hydrometeorological forecasting, including forecasting flows into major water storage reservoirs was developed 30 to 50 years ago, so it doesn't match the current state of the hydrological network and modern data collection and processing techniques.

There are no up-to-date flood risk maps for the Amur floodplains which would enable the local residents and landowners to be informed about the nature and the extent of the risks. For most of the residents in the flooded areas the disaster was totally unexpected – partly because no adequate effort was made to inform them and partly because these areas were not considered flood-prone.

Prominent experts and heads of relevant government agencies in Russia believe that the following steps to improve the situation need to be taken:

- a. Conduct research to measure river channels' conveyance capacity and research the flooding conditions for specific areas in the Amur basin;
- b. Research emergence patterns of extreme hydrometeorological phenomena;
- c. Support development of physics and mathematical hydrological models and methodologies for forecasting dangerous floods in the Amur basin adapted to the existing network of the Roshydromet monitoring stations;
- d. Support development and application of GIS technologies for data visualization and on-the-spot decision-making.

The Sino-Russian Joint Report on the 2013 Flood on the Amur River concludes that China and Russia need to establish a basin-scale coordination mechanism and suggests the following joint work in flood control be carried out step by step:

- i. Strengthen the hydrological monitoring network establishment, which currently has a low density and lacks gauging stations at which river discharge is measured on the main stream of the Amur River, and improve the collection of rainfall data by carrying out some cooperative research on rainfall monitoring techniques based on radar or satellite remote sensing.
- ii. Information sharing enhancement: optimize the existing set of data-exchange station networks, regularly exchange and check the basic information of hydrometric stations and the main reservoirs.
- iii. Share methodologies and enhance cooperation on hydrological forecasting in the Amur River basin, including cooperation on the development of the Amur River basin hydrological model and flood forecasting operating system.
- iv. Conduct joint research on:
 - 1) Fluvial processes based on satellite and remote sensing technology;
 - 2) Impacts on rivers and flooding due to human activity or large hydraulic engineering structures;
 - 3) Impacts on floodplain and ecological environment caused by changes in flooding and fluvial process.

We believe that the following measures should also be added to the above lists:

- A. Provide open access both to the raw data and the results of analysis to inform the population and ensure data verification by independent experts;
- B. Design programs to inform and educate the population about potential flood risks in specific areas. *(For more see Chapter VI of the Report.)*

F. International Cooperation

China shares with Russia greater transboundary water resources than with any other country, and for both countries transboundary water management is among one of the highest matters of national security. Either side won't be able to develop unilaterally valid Integrated Flood Management Program for transboundary watercourses. We suggest the following areas of priority to aid cooperation:

- a. Continue and expand cooperation based on successful preparation of the Joint Report on the 2013 Flood on the Amur River. Using the meteorological and hydrological data that is analyzed in this report and adding the missing data such as the environmental and socio-economic condition of the Amur River basin, develop flood mapping for different scenarios to help identify flood risk. From both sides engage a wider spectrum of agencies and stakeholders in developing the new report to kick off effective and comprehensive cooperation.



Amur Basin Water Management Bureau Andrey Makarov and his Chinese counterpart Dr. Li Yuan inspecting dykes in Komsomolsk-on-Amur by Rivers without Boundaries Coalition

- b. In the framework of providing joint Sino-Russian scientific information support to IWRM, an integrated model of the Amur basin should be developed, together with a map of transboundary river valleys. This will enable both sides to conduct ongoing real-time monitoring of waterways, hydraulic facilities, floodplains, hydropower complexes' operational regimes and precipitation levels at monitoring stations on both the Russian and Chinese territory, which will allow them to forecast flow volumes throughout the basin. This would support the following goals:
 - i. Take timely steps to protect population and economic facilities from floods;
 - ii. Monitor the state of floodplains' and other wetlands' natural flood management capacities;
 - iii. Plan the construction and development of hydraulic facilities, and regulate land use in floodplains;
 - iv. Efficiently use flood management capacities of both sides' water storage reservoirs to reduce dangerous discharges and water levels in the basin's rivers.
- c. Learn from each other's policies and flood management practices. In particular use the China National Zoning for Ecological Function Management (2015) to delineate a complementary eco-functional zone for flood retention and biodiversity conservation in the transboundary Middle Amur River. A similar zone already exists along the Nen and Songhua rivers to protect biodiversity and natural flood regulation ecosystem services provided by Song-Nen Plain wetlands.
- d. Jointly develop comprehensive climate adaptation programs for transboundary river basins. Initiate development of bilateral (Eastern part of Amur River basin) and trilateral (Western part – Dauria Steppe rivers) adaptation planning process.
- e. Russia and China should agree on standards for transboundary riverbank protection by dykes because such construction reduces the flood retention capacity of natural floodplains and creates higher maximum water levels during floods.

G. Preserving ecosystem services of natural floodplains

A river's floodplain plays a major role in fresh-water ecosystems. It serves as a factory supporting reproduction of meadows, floodplain forests, fish, amphibians and reptiles, water and marsh fowl as well as aquatic and coastal mammals. Huge amounts of biogenic elements are accumulated in floodplains thus increasing their productivity. Floodplains have many times more forage for fish, waterfowl and mammals than river channels do. Periodic flooding of the floodplain is an important driver of its biological productivity. To function normally a floodplain needs to be periodically flooded.

More than one hundred fish species inhabit the Amur River and its floodplains' water bodies, 18 of which are endemic. The river's floodplains are home to 320 terrestrial vertebrate species, 340 aquatic and coastal species; the floodplains' forests consist of 300 species of vascular plants.

The total area of natural floodplains along large watercourses of the Amur basin was estimated at 80,341 square kilometers. Rough calculations show that when covered with a layer of flood

waters just 2 meters deep such floodplains could hold approximately 160 cubic kilometers of water. Total retention capacity just on nine floodplain stretches of the Zeya and Amur rivers during the 2013 flood calculated on maximum water levels was about 130 cubic kilometers. It is obvious that during the 2013 flood, water volume accumulated by natural floodplains was greater than live volume of existing or planned hydropower reservoirs of the Amur River basin.



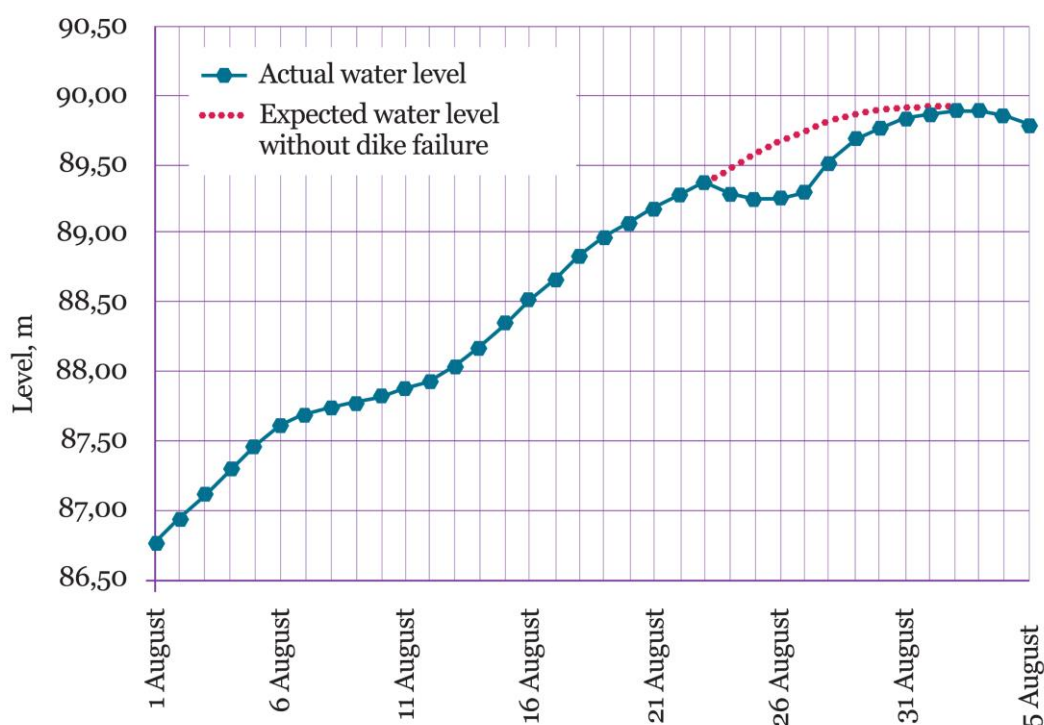
**Floodplain of the Genhe River after flooding
by Dan Hanisch**

By the 1980s, the substantial evidence of negative environmental consequences of hydropower plants on rivers and their floodplains in Russia had prompted a more cautious approach to building hydropower plants. In the 2000s, concerns about the Amur's ecological health started to grow, in particular about the pollution of its waters and diminishing fishing stocks. This has prompted a change in the Russian position of the Russian-Chinese negotiations on the Amur basin. In 2000, Russia shelved a joint plan to build hydropower in the main channel of the Amur River and since then this idea has been opposed not only by NGOs and scientists, but also by local communities and provincial governments.

Flood protection dikes have more localized but even more radical impact on floodplain ecosystems. Diking of river banks prevents flooding of floodplains and may lead to degradation of soils due to disruption of soil formation processes, as a result of lack of natural moisturizing and insufficient inflow of nutrients. The reduced size of flooded areas in floodplains results in reduced spawning areas, which negatively affects rivers' fisheries capacity. Construction of bank

reinforcement dikes narrows the flow and increases its depth and speed, thus destroying the spawning grounds and other habitats.

Due to construction of dikes and other hydraulic facilities (especially in the Chinese section of the Amur basin), some of the floodplains no longer accumulate flood waters. This results in increased maximum water levels during floods. For example, this was vividly demonstrated by the failure of the Bacha dyke in August 2013, which resulted in an inundation of 764 square kilometers with a retention of 4.1 cubic kilometers of water. It can be seen on the figure below that the Bacha dike failure decreased water levels at Fuyuan and Khabarovsk, decreasing flood damage in those areas.



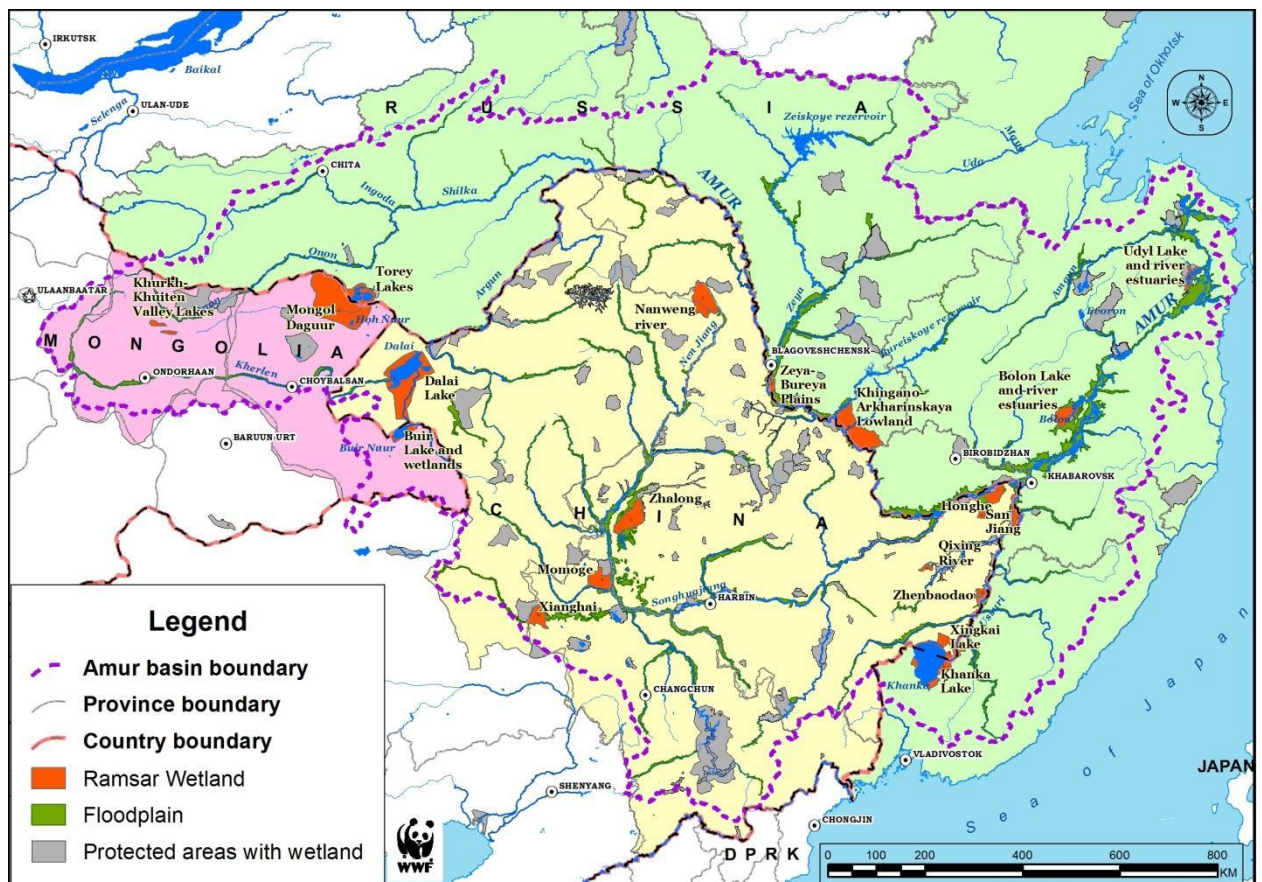
Influence of the Bacha dike failure on a hydrograph at Fuyuan Station. The red line indicates what the hydrograph would look like without dike failure ²

The total area of protected wetlands of the Amur River basin is comparable in Russia and China (~3 million hectares in each country) but of those, China has a three times larger share of protected floodplains (1.5 million hectares) which are especially important from the flood management point of view.

² Sino-Russian Working group Chinese-Russian Joint Report on the Analysis of the Extreme Flood in Amur River in 2013 / Bureau of Hydrology, Ministry of Water Resources, China; Water Problems Institute, Russian Academy of Sciences. – Beijing: Sino-Russian Working group under Agreement on Transboundary Waters, 2015.

In 2011, China and Russia adopted the “Sino-Russian Strategy for Development of Transboundary Network of Protected Areas in the Amur River Basin for the Period till 2020”. Inventory and protection of wetlands is the highest priority in that strategy.

The global importance of the Amur basin wetlands and floodplain wetlands in particular is demonstrated by the fact that it already has 20 sites listed under the Ramsar convention as wetlands of international importance. At least two thirds of those contain large floodplain complexes and seven of them are located on transboundary watercourses.



Wetland sites listed under Ramsar convention by Amur branch of WWF-Russia

Integrated Flood Management planning should take into account the floodplains potential to accumulate significant amounts of seasonal flood waters, as well as the objectives to preserve biodiversity and sustain other important ecosystem functions of floodplains. Biodiversity conservation is often achieved by the establishment of protected areas, which by their legal regime are also well suited to protect natural flood retention areas from undue development. This shows huge potential for synergy between biodiversity conservation and flood risk reduction in the course of river basin management planning and implementation.

In addition to recommendations described in the previous sections we suggest the following priority measures for floodplain protection:

- a. Regulations should be issued by each country limiting allowed reduction of flood-plain retention capacity by dykes and other engineering means;
- b. Create economic and policy incentives to promote such types of land-use on natural flood-plains that are fully compatible with a flooding regime and preservation of wetland ecosystems;
- c. Define new optimal flooding levels in the floodplains under the new conditions in order to specify environmental flow requirements for existing (and planned) hydrological engineering facilities. Incorporate environmental flow norms into flow regulation plans of the Zeya and Bureya reservoirs;
- d. Conduct joint Sino-Russian field studies in floodplain complexes in the transboundary valleys of the Argun, Amur and Ussuri rivers. Jointly estimate the floodplains' retention capacities at various stretches of the transboundary Amur trunk and its main tributaries;
- e. Assess the importance of various floodplain areas in terms of their natural flood attenuation potential, depending on their water accumulation capacities, location and economic development level. Assess anthropogenic and natural factors that negatively affect river channel capacity thus increasing flood risks. In particular, assess the share of floodplains' natural retention capacity lost due to construction of dykes, polders and other facilities;
- f. Identify zones where the risk of further construction in floodplains exist, or other risks associated with development incompatible with their flood management functionality. Based on the results of the conducted studies and in consultation with the WMO Associated Flood Management Programme, develop a bilateral action-plan to preserve and restore the floodplains' flood retention functions, and regulate land use in the transboundary river valleys (Argun, Amur, Ussuri). That would reduce the risks of and damages from disastrous floods;
- g. Based on the results of this joint study and on the Russian-Chinese Strategy for the Development of Transboundary Network of Protected Areas in the Amur Basin (2011–2020), prepare recommendations on establishing protected areas in floodplains which are particularly important in terms of accumulating flood waters and preserving valuable natural ecosystems, rare and endangered species and outstanding concentrations of migratory species. *(For more see Chapter VII of the Report.)*



The Argun River floodplain
by Eugene Simonov