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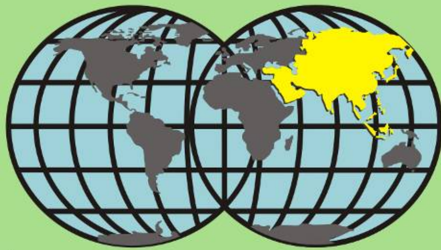

Inter Academy Panel on international Issues (IAP)

RUSSIAN ACADEMY OF SCIENCES
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THE REGIONAL WORKSHOP

Strengthening the Collaboration between the AASA Clean Water Programme and the IAP Water Programme

20-23 October, 2009

Barnaul 2009

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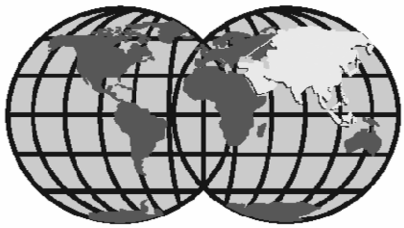

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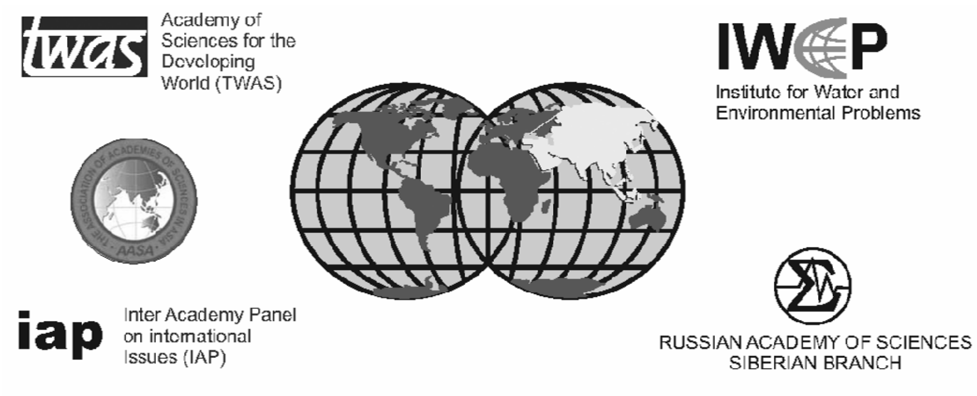

РЕГИОНАЛЬНЫЙ СЕМИНАР

УКРЕПЛЕНИЕ СОТРУДНИЧЕСТВА В РАМКАХ ПРОГРАММЫ АССОЦИАЦИИ АКАДЕМИЙ НАУК АЗИИ "ЧИСТАЯ ВОДА " (AASA) И ВОДНОЙ ПРОГРАММЫ МЕЖАКАДЕМИЧЕСКОЙ АССОЦИАЦИИ (IAP)

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The Proceedings represent the papers dealing with some topical issues on water resources and their use in different countries. The possibilities for problems solution with the involvement of international experience and cooperation of scientists and experts as in the framework of international programs "Clean Water – A Step Forward" (AASA) and World Water Program (IAP Water Program) are considered

В сборнике представлены доклады, в которых обсуждаются актуальные проблемы водных ресурсов и их использования в различных странах мира. Рассматриваются возможности решения данных проблем путем привлечения международного научного опыта и международной научной кооперации ученых и специалистов как в рамках отдельных международных программ «Чистая вода-шаг навстречу» ААНА и Мировой водной программы (IAP Water program), так и при их совместных усилиях

Materials presented interesting for water managers and research institutes involved in water-related issues study.

All papers are printed in author's alteration.

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Progressive development of cross-borders water resources for sustainable water supply in arid basins – proposed solutions for the Middle East

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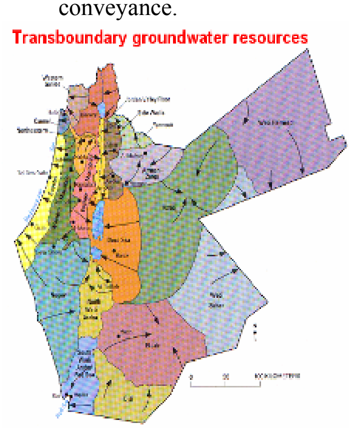
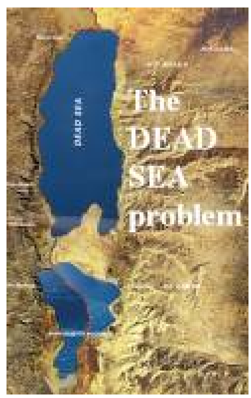
- **Water Shortage**: Shortages of water in various qualities for different end users already exist in Mediterranean countries. In the very near future, the situation in the eastern Mediterranean, following climate change that envisages a dramatic decrease in rainfall, will grow worse. Therefore, due to an anticipated massive increase in population, as well as elevated living-standards, the demand for additional water for domestic use and food production will increase.

- **Cross-Borders Water resources**: All major water resources (rivers and groundwater reservoirs) are transboundary water bodies. In general, the riparian (downstream) users depend on the upper basin activities for both availability of adequate quantities and quality of water. Example from the Jordan River basin – the Red-Dead Seas conveyance.



The combined impact of increase in water demand, deterioration in water quality, negligible volume for operational water reservoirs, and the issues related to management of transboundary water resources are illuminated, elaborated, and discussed in details



- **Surface water resources** in the Middle East region of the eastern Mediterranean (mainly the Jordan River basin) are fully exploited and the water quality is deteriorating dramatically over time. Most of the other (smaller rivers) are already heavily contaminated

- **Groundwater** is the best long-term storage reservoirs believed to be better protected from negative anthropogenic impacts.

- **Sub-Surface Water Reservoirs**: Groundwater resources in the eastern Mediterranean are fully developed and prone to salinization and contamination and as a result, groundwater quality is declining with time.

- **The Sea of Galilee**: The only fresh water reservoir that can be used as an operational reservoir, buffering from winter/summer and wet/dry year fluctuations, is the Sea of Galilee. Therefore the region lacks in operational reservoirs, with all the ensuing consequences.

- The **Agriculture Industry & Remediation of Effluents**: The massive development of advanced agricultural industry in Mediterranean countries, including the Middle East, endangers the two major natural resources, soil and water. Most of the coastal aquifers all already impacted by anthropogenic activities including contaminants such as pesticides, herbicides, and fertilizers migrating across the vadose zone into groundwater

- Long **term water shortage leads to the most advanced water technologies:** Israel managed to develop its economy and its agriculture industry by implementing technological innovations and by the development of the most advanced water technologies!

The presentation elaborates on the **most advanced solutions** deployed in Israel, to meet the increasing demand for various types of water by various end users (agriculture industry versus domestic users).

The presentation also emphasizes the **hydrological complexity in the eastern Mediterranean countries,** due to water shortage, massive groundwater exploitation, urbanization, agriculture and industrial impact on water availability and quality associated with limited trans-boundary water resources.

The future is ours to choose!

The presentation ends with suggestions for assuring sustainable water supply in the Middle East, to meet the future needs and demand:

- Coordinated management of existing water resources;
- Treating-remediating effluents for reuse in agriculture industry;
- Common production of "new water" (desalination of sea and brackish groundwater).

Hydrological background of water dividing in Central Asia

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In the report the results of the project "Interstate Water Resource Risk Management: Towards A Sustainable Future for the Aral Basin (Jayhun 516761)" are discussed. The project was co-funded by the European Commission within the Sixth Framework Programme (2002-2006).

1. Methodology of the investigation

The project was aimed on the prediction of available water resources allowing adequate risk management strategies and taking into consideration the water demands. The main idea for the Jayhun project is drought (low flow) risk assessment with the help of modelling concept, by combination of modelling processes for (i) the drought risk assessment under current conditions (Figure 1), and (ii) the assessment of risk management under future conditions (Figure 2).

A few approaches where used to solve the task. First the Glaciological data base was created. After combining data of Glacier Inventories, computational results using remote sensing images and application of GIS techniques, the data on fluctuation of the glaciers size in the Upper Amudarya during 1960-2000 was received. These data was used in the framework of Jayhun Project for substantiated modelling of glaciers runoff in the Upper Amudarya.

The software was elaborated and applied which allows solving the following hydrological problems:

a) Stochastic modelling of artificial realizations of precipitation, air temperature and river runoff in the given stations needed for further hydrological calculations;

b) Bayesian forecasting of runoff in the zone of its generation in the presence of several climate scenarios for further risk estimations;

c) Elaboration of water balance calculation scheme for the Amudarya basin (minus Zeravshan) based on the WEAP model;

d) Software for the estimation of filling up of water storage reservoir by sediments;

e) Elaboration of the method for the solution of the zonal runoff problem for evaluating the influence of glaciation border displacement in the conditions of changing climate.

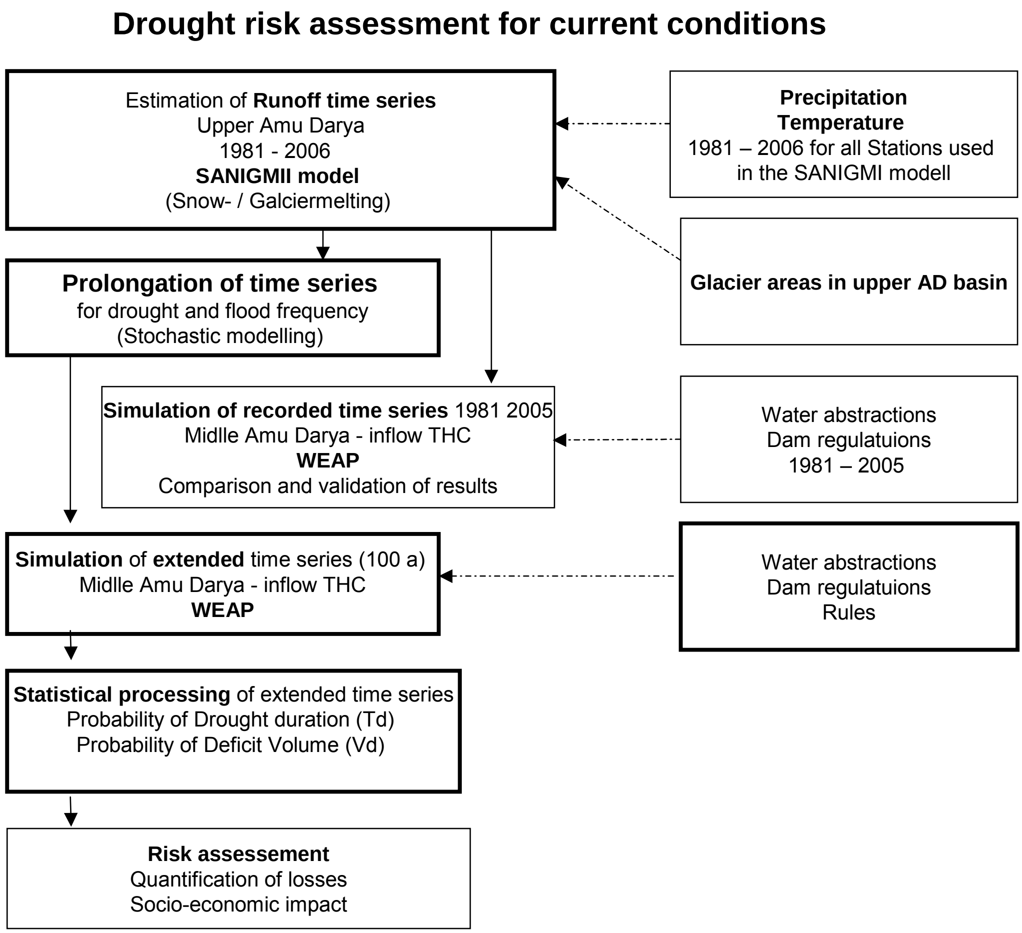


Figure 1 Modelling scheme for a drought risk assessment under current conditions

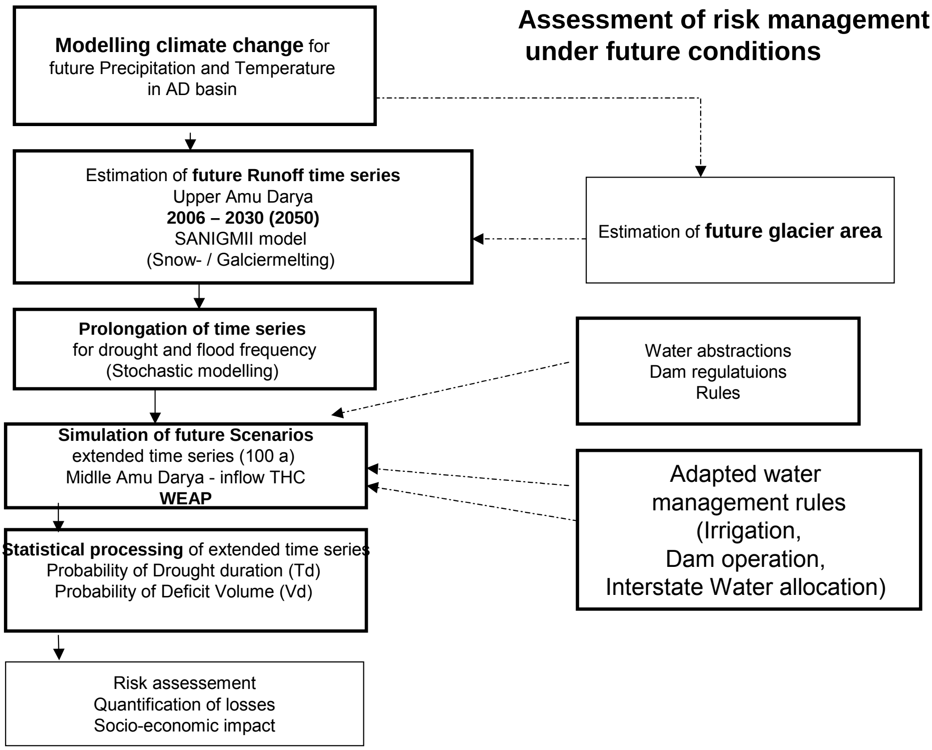


Figure 2 Modelling scheme for the assessment of risk management under future conditions

2. Glaciation data

The basic part of glaciation inside the Aral Sea Basin is located within the watersheds of Vakhsh and Pyandj rivers that are the main tributaries of Amudarya. Current distribution of glaciers in the Upper Amudarya is shown on Fig. 3 prepared after processing of remote sensing images for Pamir and Hindukush from satellites LANDSAT 7 and TERRA.

The data on long-term change of glaciers size are necessary for modeling and forecasting of water resources in the Amudarya river basin. The total area of a glacier and its morphological components (accumulation and ablation fields, bare ice and moraine cover) are main characteristics for hydrological calculations and analyzing relationship between the climate change and the fluctuation of glaciers size. At present, the reference books (Inventory 1971-1978, Schetinnikov, 1997) are the sources of the data on glaciers size change related to two temporal cuts. Those are: approximately the end of 50-th and 1980 in the Vakhsh River and right tributaries of the Pyandj river basins and only 1960 for the left tributaries of Pyandj (Ivan'kov, 1970).

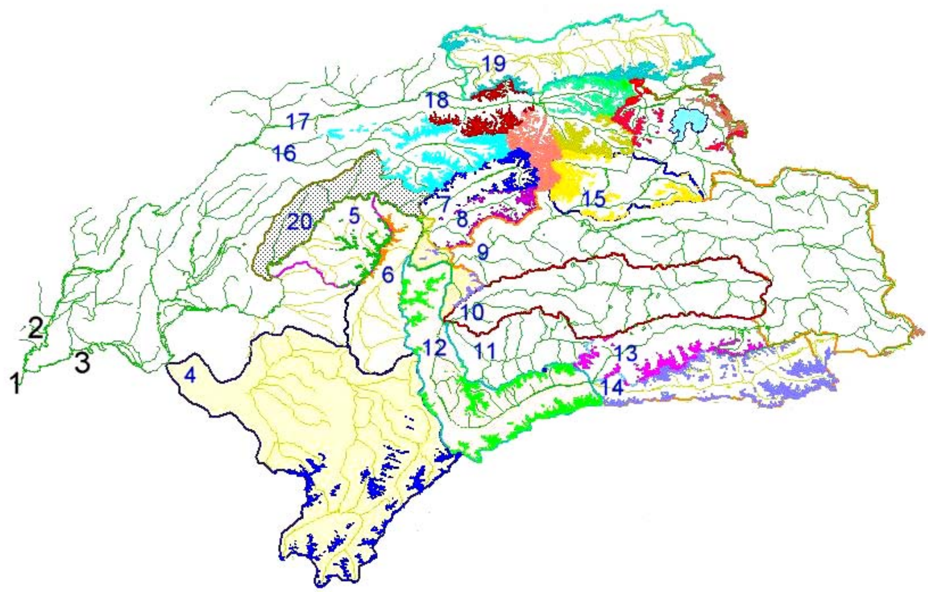


Figure 3. Glaciers in the Upper Amudarya basin. 1 – river Amudarya, 2 – river Vakhsh, 3 – river Pyandj, 4-15 tributaries of the Pyandj river (4 – Kunduz, 5 – Kufab, 6 – Sheva, 7 – Vanch, 8 – Yazgulem, 9 – Bartang and Murgab, 10 – Gunt, 11 – Shahdara, 12 – right and left tributaries of Pyandj downstream the confluence of Pamir and Vahandarya rivers, 13 – Pamir, 14 – Vahandarya, 15 – Kudara), 16-20 are tributaries of Vakhsh river (16 – Obihingou, 17 – Surhob, 18 – Muksu, 19 – western Kyzylsu, 20 – right tributaries of Vakhsh downstream the Vanch river mouth).

Large gap of information for the considered area is filled now both by computational methods and processing remote sensing images of Pamir and Hindukush mountain areas obtained during 2000-2001 from LANDSAT 7 and TERRA satellites. Methodical approaches used at this stage of the researches are presented in the publications (Agaltseva, Konovalov, 2005; Konovalov, Williams, 2005; Konovalov, Desinov, 2007).

After combining data of Glacier Inventories, computational results using remote sensing images and application of GIS techniques, the data on fluctuation of the glaciers size in the Upper Amudarya during 1960-2000 were received.

3. Modeling tools: stochastic modeling of the river runoff and meteorological characteristics

Beginning with Bagrov (Bagrov, 1959), etc., the Empirical Orthogonal Function for expansion of hydro meteorological fields (EOF expansion method) is widely used in hydrometeorological forecasting. Following (Bagrov, 1959), let us consider a problem.

Let a sequence of meteorological fields be given for a certain area of the earth's surface. The sequence is designated by F(t, x), where t is the time assuming discrete values: t = 1, 2,…, m; x is a coordinate parameter: x=1, 2,…, n.

Let us find the decomposition of any field out of the available population of fields in some functions Xh(x), h=1, 2,… with coefficients T(t) varying from one field to another. After Bagrov, we have to find the function Xh(x) such that the following expansion takes place:

$$F(t,x)=\sum_h T_h(t)X_h(x). \quad (1)$$

Functions Xh(x) are a priori unknown, and they should be determined from data on the available population of fields whose properties determine individual features of unknown functions. The function Xh(x) and thus Th(x) are defined from the following conditions: the sum of squared errors of expansion (2.4) over all field realizations must be minimal.

The sequence of EOF expansion coefficients are linear functions of an initial field; hence, the distribution parameters T(t) and ordinates of their autocorrelation functions can be calculated by the theorem on linear transformation of a random function.

To estimate reliability of the water utilization system functioning of the Amudarya basin, the stochastic model is proposed which allows reproducing of long runoff series in its formation zone. On this stage, the parameters of the runoff distributions of the catchments under investigation correspond with stationary modern climatic conditions. On the next stage, they will be replaced by the new ones, corresponding to modern glaciation and the changed (forecasted) climatic conditions.

For the imitation modeling, the information from 6 gauge stations was taken (Table 1)

Table 1 Gauge stations used for imitation modeling

№	Code	River – gauge station	N (years)
1	QM 17045	Pyandj - Hyrmandzhow	36
2	QM 17084	Vakhsh - Komsomolabad	50
3	QM 17137	Kafirnigan - Tartki	64
4	QM 17193	Surkhondarya - Manguzar	43
5	QM 17991	Kunduz – Puli - Kumry	19
6	QM 17992	Kokcha – Hodzhagar	15

The algorithm of the multidimensional vector modeling is based on the decomposition of the field along eigenfunctions. It reproduces random variables having the given parameters of one-dimensional distributions, correlation matrix and the first value of the autocorrelation function (it is enough in the Markov approach). The transition to the monthly runoff values is executed by method of fragments (of double sampling).

Modeling of monthly values of precipitation and temperature is executed according to the scheme of the SAR- Model, i.e. the one having the seasonal trend removed. For the model adjustment, matrixes of spatial correlation, autocorrelation functions for each month and the distribution parameters of precipitation and temperature are estimated.

4. Provision of applicable river module

The principle scheme of the model complex design is given on the figure 3

The results of the conducted studies have shown that the application of the deterministic model makes it possible to develop the reliable techniques for the long-term forecasting of the spring-summer runoff.

Development of the calculation and forecasting method for each basin on the basis of the considered model includes the following stages:

- analysis of the conditions of runoff formation; preparation of maps;
- numerical description of fields of precipitation, air temperature, and humidity deficit, and determination of extrapolation formulae parameters;
- computation of rain, melted snow;
- calculation of glacial runoff (for the rivers with glaciers);
- estimation of transformation parameters for the years with different water availability (dry years, humid years and medium humid years);
- calculation of the runoff hydrograph.

The model adaptation for the Amudarya river basin consists of the following phases:

- Calculation of snow accumulation in a basin from October to the data of forecast issue (input information – the meteorological data);
- Calculation (forecast) of melted and rainfall water income to the catchment area during the vegetation period on the base of snow accumulation assessment for current year to the date of forecast issue and climate evaluations of meteorological elements for the lead time period;
- Transformation of all incomes to the runoff for control water gauge.

The preliminary phase of modeling is very important and it includes:

- Study and analyze of runoff and main runoff forming factors conditions;
- Numerical approximation of precipitation, air temperature and humidity fields with definition of their parameters;
- Definition the rest of parameters of the snow cover formation model, melted and rainfall water incomes to the catchment area;
- Evaluation of given model adequacy to the natural processes;
- Optimization of the parameters of the runoff transformation model;

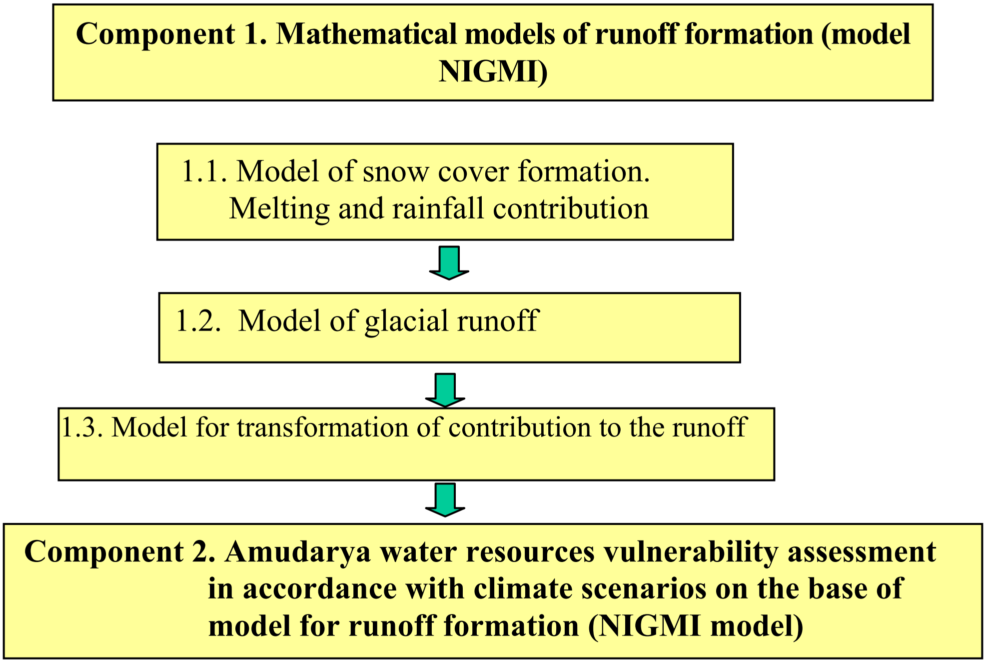


Figure 3 The principle scheme of the river model complex design

5. Elaboration of the method for the solution of the zonal runoff problem

The dependence of the river runoff on the catchment altitude serves as the principal characteristic of the hydrological regime in mountainous regions. To describe such dependence, the runoff from the river is usually associated with the average altitude of its catchment (the altitude of its centre of gravity):

$$Y=F\ (H_{av}) \qquad (2)$$

where Y is a norm of runoff, H_{av} is average altitude of a catchment.

We can represent the runoff measured on some gauge station as the sum of runoff values coming from several altitudinal zones:

$$Y = \sum_{i=1}^{n} f_i y_i$$

where f_i is the relative area of the i^{th} altitudinal zone, y_i is a zonal runoff (the runoff from an i^{th} altitudinal zone), n is the number of altitudinal zones distinguished on the catchment.

If we have data from several sites of the Y-values measurements in a homogeneous hydrological region where we assume the same specific runoff to come from a n altitudinal zone for all the gauge stations, we use a system of the equations

$$Y=Ay \tag{3}$$

The system (3) is ill-conditioned, and the inverse problem is ill-posed. This means that small changes of initial data (for example, errors of measurements) can cause great changes in the solution. In this paper, the system (3) was solved using the method of Tikhonov regularization to make the solution stable.

The regularization is carried out in this method by minimizing of the special operator, i.e. the so-called the Tikhonov's functional:

$$M^{\alpha}(y, A, Y) = \sum_{j=1}^{n}\left[\sum_{i=1}^{n} f_{j,i} y_i - Y_j\right]^2 + \alpha \sum_{i=1}^{n} x_i^2 \tag{4}$$

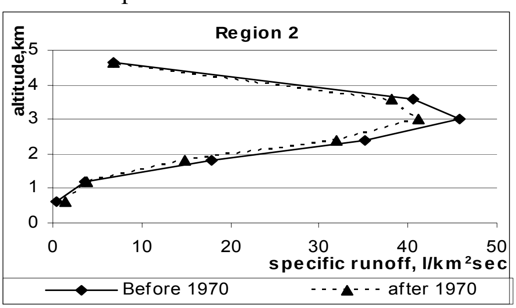
The regularization parameter α is determined from the condition

$$\rho(Ay_{\alpha}, Y_{\delta}=\delta) \tag{5}$$

The received values of the zonal runoff can characterize the main sources of the river feeding which are precipitation and snow melting. Their correlation varies in different seasons.

Recently, significant shrinkage of glaciers areas in different mountain regions is observed. See, for example, Kuzmichenok (2006) about total glaciers area in Kyrgyzstan, Stokes et al (2006) about glaciers in the Caucasus, Paul et al (2004) about Alpine glaciers area reduction. Shrinkage of glaciers in the upstream of Amudarya River was investigated by Agaltseva N.A., Konovalov V.G. (2005).

In Amudarya basin, in summer the main source of the river feeding is glacier melting, and changes in summer runoff values can be caused by glacier shrinkage. Solving the zonal runoff problem separately for summer months for the two periods: before 1970 and after 1970 can demonstrate the influence of glacier shrinkage. In Fig. 13, the solution of the zonal runoff problem for one of the homogeneous regions of the Upper Amudarya river basin is presented.



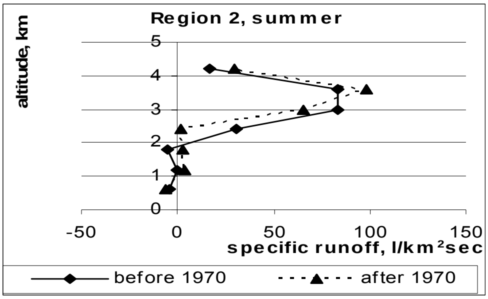


Figure 4 Values of the zonal runoff calculated by Tikhonov regularization.

6. Provision of the applicable reservoir module

Water utilization and water energetic estimations of the Rogun and Nurek water reservoirs.

Water-economic and water energetic calculations of the Rogun and Nurek hydrounits are executed by a calendar method on monthly intervals of continuous 50-years time-series from 2000/01 to 2049/50 for the variant accepted as modern, and four variants of simulated change of hydrological conditions.

The following rules of Vakhsh runoff regulation by Rogun and Nurec water reservoirs are accepted. Rogun and Nurec water reservoirs carry out seasonal regulation of the Vakhsh runoff, i.e. they increase Vakhsh runoff in the down pool of Rogun and Nurec hydrounits, during X-IV due to water volume decreasing to maintain guaranteed capacity of Rogun and Nurec hydroelectric power station in X-IV. In V-IX, they reduce it during filling of water reservoirs. Calculated guaranteed capacity of Rogun and Nurec hydroelectric power station during X-IV is set by a variable on months (in shares from $\bar{N}_{XII}$: X - 0,8; XI - 0,9; XII - 1,0; I - 0,9; II - 0,8; III - 0,7; IV - 0,6). Its probability is accepted equal to 90 % (on number of uninterrupted years).

In Figs. 5 and 6, the results of the water-energy calculations are presented, carried out for three climatic scenarios (modern climate, scenarios A2 and B2) and for two time periods (30 years and 50 years). In Figs. 5 a and b, chronologic graphs of water passes into the down pool of the Nurec water reservoir for 50 years for all the climatic scenarios are given.

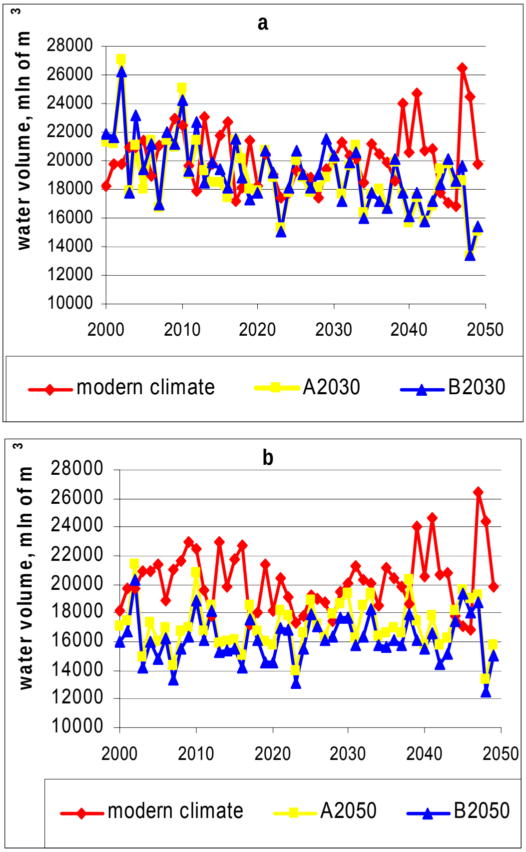


Figure 5 Water passes through the Nurek dam a) – for 30-year period; b) – for 50-year period

In Figs. 6 a and b, monthly water discharges averaged for 50-years period are shown also for two time periods.

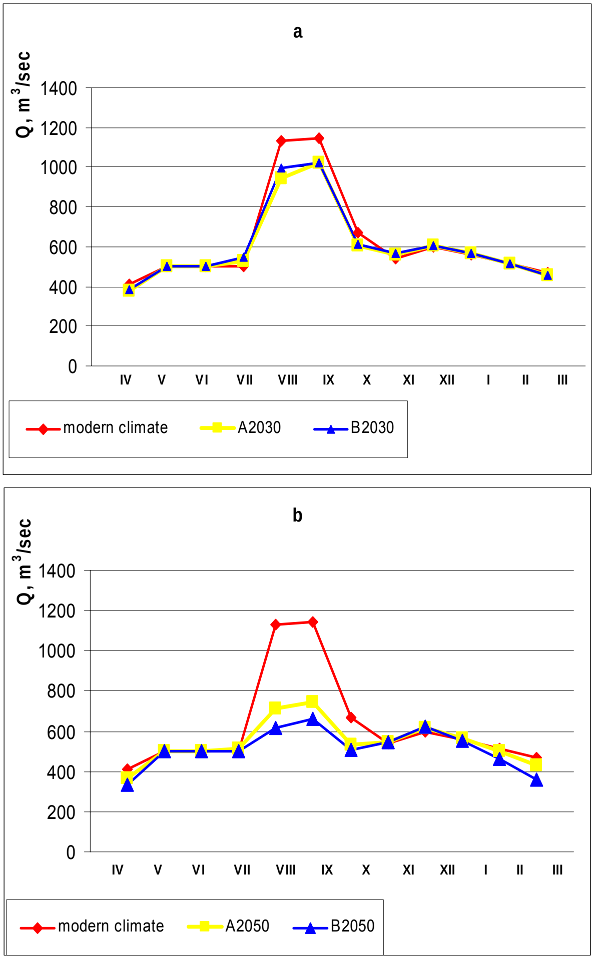


Figure 6 Average monthly water volumes for the Nurec dam: a) – for 30-year period; b) – for 50-year period

The analysis of the water passes graphs shows that for the nearest 30 years the Nurec reservoir operation regime will not depend greatly on the runoff changes. Considerable changes may occur after 30 – 50 years. In this case, energy regime of the Rogun operation will lead to the significant reduction of the Vakhsh runoff during vegetation period.

7. Bayesian forecasting (Bayesian decision) of runoff in the zone of its generation in the presence of several climate scenarios for further risk estimations

Necessity of application of Bayesian methods is caused by a few reasons. Most important reason in our project is a necessity of obtaining of estimations for non-stationary case when essentially different behaviour of river runoff process is predicted and the forecast is characterized by high uncertainty.

Frequency distribution of runoff values is characterized, as a rule, by positive asymmetry and is approximated by two-or three-parametrical Gamma-distribution. We shall limit our investigation to two-parametrical Gamma-distribution in the following form:

$$P(x_0,\gamma,x) = \frac{\gamma^{\gamma}}{\Gamma(\gamma)}\left(\frac{x}{x_0}\right)^{\gamma-1} e^{-\gamma\frac{x}{x_0}} \qquad (6)$$

where x_0 – average value, γ = 1/Cv2, Cv – variation coefficient, Γ(γ) – Gamma function.

The next point consists in the construction of forecasted frequency distribution of probabilities of water runoff on the base of the formula of total probability. In that case forecasted frequency is estimated as follows:

$$\pi(x) = \int_{\theta} P(x,\theta)\cdot p(\theta/x)d\theta \qquad (7)$$

where $\boldsymbol{p(\theta / x)}$ - a posteriori frequency distribution of parameter θ, $P(x,\theta)$ - two-parametrical Gamma-distribution with preset parameter γ. As a result of numerical integration (7) we shall obtain Bayesian forecasted frequency distribution of probabilities of investigated runoff characteristics.

In our case only three conditions of the process are available and we can assume only, that the system with probabilities both n_1/N, n_2/N and n_3/N can be in one of them. Here $n_1 + n_2 + n_3 = N$, where N is sum of chances.

Concerning future fluctuations of runoff we only can approve, that with corresponding probabilities the system can be in one of two conditions. In that case it is possible to assume, that average of distribution of forecasted process is a combination of three distributions.

$$\tilde{p}(\theta/x) = \frac{n_1}{N}\cdot\eta_1(\theta,x) + \frac{n_2}{N}\eta_2(\theta/x) + \frac{n_3}{N}\eta_3(\theta/x) \qquad (8)$$

where $\eta(\theta, \boldsymbol{x})$ - sample distribution of average value (average of distribution) for the i-st scenario with weight ni, and $\boldsymbol{p(\theta / x)}$– a posteriori frequency distribution of of Bayesian estimation θ for predicted climatic conditions. It is easy to notice, that frequency distribution (8) is three-modal because sample frequency of average of distribution is Gaussian and a posteriori frequency $p(\theta / x)$ at small dispersion also is close to normal law.

The final stage of Bayesian estimation (forecasting) consists in calculation of forecasted frequency distribution using the formula of total probability. In this case combination of distributions (8) will be presented as a posteriori distribution, and modelling distribution will be two-parametrical Gamma-distribution (6) with parameter γ, equal to average value for all scenarios:

$$\pi(y) = \int_{\theta} P(y, \gamma, \theta) \cdot \tilde{p}(\theta / x) d\theta \tag{9}$$

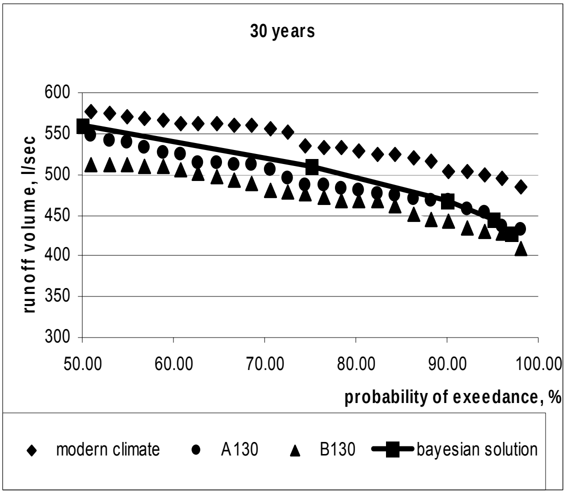
Thus, on the basis of Bayesian formula, the results of forecasting with account of future climatic changes uncertainty can be represented in the probability form and used for further estimations of water consumption.

The obtained forecasted frequency distribution will not be any more Gamma-distribution and will be calculated by numerical integration of the equation (9). In Table 2 and Figure 7 we can see the result of the numerical calculations for river Vakhsh – town Komsomolabad and river Amudarya, gauge station Kerki.

As a result of application of Bayesian ideologies, forecasting cumulative probabilistic curve of annual runoff was obtained, based on setting of various weights to estimations of average value for conditionally homogeneous periods and calculation of forecasted frequency distribution using formula of total probability. By application of the described procedure, annual water runoff value was estimated. Thus, regular application of the theorem of Bayes allowed to precise estimated (predicted) characteristics of annual river runoff in the Upper Amudarya river basin and to evaluate reliability of water supply.

Table 2 Cumulative probabilistic curves of annual runoff, river Vakhsh – town Komsomolabad

No	Time lag	Weight, % for scenario			Probability of exeedance, %				
		Modern climate	Scenario A1	Scenario B1	50	75	90	95	97
1	30 years	50	25	25	560	510	468	444	429
2	50 years	50	25	25	539	479	431	407	392



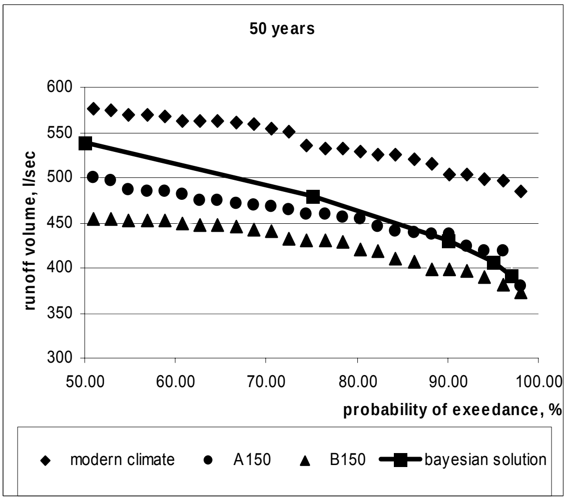


Figure 7 Distribution of the runoff for Vakhsh– town Komsomolabad for different climatic scenarios

Table 3 Cumulative probabilistic curves of annual runoff, river Amudarya - gauge station Kerky

No	Time lag	Weight, % for scenario			Probability of exeedance, %				
		Modern climate	Scenario A1	Scenario B1	50	75	90	95	97
1	30 years	50	25	25	1860	1730	1610	1550	1500
2	50 years	50	25	25	1800	1644	1516	1440	1400

References

Agaltseva N.A., Konovalov V.G. (2005) Projected change of glaciers size and river runoff in the different scenarios of future climate. «Exchange of intellectual property», vol IV, № 8. pp. 37-47. (in Russian).

Ivan'kov P.A. (1970) Contemporary glaciation in the upstream and lef tribitaties of Amudarya river. Proc. VGO, vol. 102, issue 3, pp. 239-244. (in Russian).

Inventory of USSR glaciers. Vol. 14, issue 3, parts 7-12. (1971-1978). Leningrad, "Hydrometeoizdat" Publishing House. (in Russian)

Konovalov V., Desinov L. (2007) Remote Sensing Monitoring of Long Term Regime of the Pamirs Glaciation. Remote Sensing for Environmental Monitoring and Change Detection (Proceedings of Symposium HS3007 at IUGG2007, Perugia July 2007). IAHS Publ. 316, 2007. In press.

Konovalov V.G., Williams M.W. (2005) Long term fluctuations of glaciers and river runoff within Central Asia at the current climate conditions. Meteorology and Hydrology, No 9, pp. 69-83. (in Russian).

Kuzmichenok V.A. (2006) Monitoring of Water, Snow and Glacial Resources of Kyrgyzstan. Regional Workshop on Assessment of Snow-Glacier and Water Resources in Asia. Almaty, Kazakhstan. 28-39 November 2006. pp. 125-143.

Paul Frank, Maisch Max, Kellenberger Tobias, and Haeberli Wilfried (2004). Rapid disintegration of Alpine glaciers observed with satellite data. Geophysical Research Letters, Vol. 31, L21402

Schetinnikov, A.S (1997) Morphology of glaciation inside of Pamiro-Alay river basins as related to 1980. Reference Book. Tashkent, "SANIGMI" Editorial Board. (in Russian)

Stokes, C.R., Gurney, S.D, Shahgedanova, M., Popovnin V. (2006) Late-20th-century changes in glacier extent in the Caucasus Mountains, Russia. Journal of Glaciology, Vol. 52 No. 176, pp. 1-11.

Problems of nature management within the transboundary Ural basin

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The breach of the basin principle of nature management in the Ural basin within the Russian-Kazakhstan sectors is one of vivid examples of the modern ecological situation. New state frontiers determined not only the geopolitical changes but the serious changes in the ecological situation as well.

The Ural is the third river in length in Europe and has the catchment area (including the drainless areas) of 380 thousand square kilometers. The river is characterized by sharp seasonal pattern of flow – nearly 20 average annual flow and about 1300 of the water discharge in the course of year. The surface runoff of the river is formed in the upper and middle parts of the basin within the Russian Federation. Downstream Ural'sk city (Republic of Kazakhstan) the river has no tributaries and loses about 20% of the total runoff on its way to the Caspian Sea. It should be noted that the Ural is the only river with the unregulated middle and lower courses on the south slope of Europe [1].

One of the most urgent problems of nature management in the transboundary Ural basin is the intensive economic development of the region. The largest industrial enterprises such as the Orenburg and Karachaganak gas complexes, Magnitogorsk and Orsk-Khalilovsk metallurgical works, plants for extraction and processing of copper ore including the Gaisk, Sibai, Mednogorsk, Baimak and Buribaisk ones as well as the Orsk nickel factory and the works for chrome extraction in Aktubinsk oblast are found within the basin.

Taking into account of economic activity and geographical characteristics of the Ural basin one can specify three functional parts. The upper part includes the catchment areas of the Upper Ural with a system of small rivers; the middle connecting part incorporates a system of convergent valleys of large tributaries (rr. Suunduk, Or', Kumak, Sakmara, and Ilek) and the main river; the third part involves the lower stream without tributaries and the mouth.

The upper part is presented by the main river and the tributaries – rr. Hudolaz and Tanalyk. The works of mining industry are the principal source of river contamination. Hudolaz river is polluted by mine and waste waters. High concentration of heavy metals in the river is due to the functioning of a joint-stock company "Bashkir copper-sulphur factory". The waste water discharged from the Buribaevsk mining factory is responsible for the pollution of Tanalyk river by heavy metals. The effluents concentration increases dramatically in autumn and winter periods; that is due to dry summer and thus the reduction of water volume in the rivers. Because of the heavy contamination of the current in the upper part of the Ural basin it is desired to search for means of treatment of liquid and solid wastes from mining works.

The Ural water in the middle stream (within Orenburg oblast) is characterized by high content of chlorine- and sulphate-ions, and iron, phenol, and oil products. The complex ecological-geochemical situation is observed within Orsk Novotroitsk and Orenburg industrial cities. Ilek river is one of the branches of the middle hydrographical link; it is the left bank tributary of the Ural that originates from Republic of Kazahstan. The total length of the river is 643 kilometers, the largest part of which (342 kilometers) covers Orenburg oblast. Zinc and copper are the main elements that form the hydrochemical background of the Ilek upper riverhead.

The excess of maximum permissible concentration for these elements is caused not only by natural conditions, but due to the anthropogenic impact as well. The study of the high concentration of hexavalent chrome in the Ilek is of crucial importance.

One more urgent problem of the current nature management is the regulation of the Ural flow and its tributaries, especially in the upper reach. Noteworthy is the multiple character of this problem that is associated with the complex scenario of water use. On the whole, the hydraulic works refer to the compound engineering structures the optimal functioning of which provide the stable geoecological state of water ecosystem, including the regulation of water level in the flood time. Very important social aspect for reservoir construction is the use of their recreational potential. However, a number of negative aftereffects of the exploitation of the hydraulic works such as the flooding of the territories, the change of the riverbed, the decrease in biological productivity of the flood plain, the worsening of fish reproduction, the loss of the unique natural objects, etc. should be taken into account.

The Ural overregulation is rather high: the total effective volume of reservoirs within Orenburg oblast makes up 3.2 cubic kilometers, including 3 cubic kilometers for the Ural basin. At present, more than 20 reservoirs have been constructed, and 11 of them are situated within the Russian Federation. The Iriklinsk hydroelectric complex is the largest within the Ural basin; it regulates the flow and provides water supply for the Orsk-Khalilovsk industrial complex, irrigation and fishery. Verhneuralsk and Magnitogorsk hydroelectric complexes in Chelyabinsk oblast maintain a sufficient water supply of industry and communal services within the Magnitogorsk industrial center and support the sanitary discharge in Ural river. Except for 16 large hydroelectric complexes (with a volume of more than 10 million cubic kilometers) and about 80 hydroelectric complexes with permanent structures, more than 3100 embankment dams were constructed on small rivers in Bashkortostan, Chelyabinsk, Orenburg, Aktyubinsk and West-Kazakhstan regions. These objects retard about 40-50% of the spring flow in a high-water year and about 85% of spring flow in a low-flow year. A considerable number of hydroelectric complexes are undesigned that increases the probability of regional ecological threat within the Ural basin. Some instability provokes the breach of the hydroelectric complexes operation in the flood time. Particularly, in Orenburg oblast 22 hydroelectric complexes are considered to be potentially dangerous (with capacity of more than 1 million cubic kilometers), and their failure will bring the threat to the downstream settlements and economic objects.

One more problem of the current nature management is the ploughing up of virgin and fallow land within the transboundary Ural basin. This is a principal factor responsible for the change of the surface runoff, erosion processes and the silting of springs, valleys and riverbeds. A virgin ploughing up covers more than 65% of the Ural basin that didn't give the expected cost-performance, but resulted in the deterioration in hydrological regime and positive ecological effect of the powerful and protracted spring flood.

Consequences of the deforestation determine the flow rate within a considerable part of the Ural basin. The area of the native forests within the Ural middle and lower stream decreased 8-10 times. The percentage of forest land within the right tributary, r.Sakmara, reduced up to 20%. The unsystematic deforestation caused the replacement of valuable floodplain forests (oak, elm, lime) with a maple. The fires adversely affect the Ural's and Sakmara's floodplain forests as well.

The Ural in its middle and lower reaches is destined for fishery. The exhaustion of biological resources is due to the excessive catch of valuable species of fish, poaching and the breach of the conditions for spawning. The catastrophical reduction of sturgeon was caused by the breakdown of the state system for protection, reproduction and fishery established in the USSR [2].

Ural river is not the main landscape-architectural component of the general town planning scheme for most of towns within the basin. Although both Russia and Kazakhstan are the successors of river civilization, the Ural is situated in the outskirts of the towns, and for many villages the Ural and its tributaries still remain as the “gutters”. The river pollution by domestic wastes is the strong anthropogenic factor influencing the Ural basin ecosystem.

To optimize the nature-conservation measures it is proposed to establish the national park “Ural'skaya Urema”. The park is expected to occupy the Ural floodplain within the state reserves “Kindelinsky” in Orenburg oblast and “Kirsanovsky” in West-Kazahstan region with total area of about 120 hundred hectares.

The park zone of rest will include the samples of the floodplain oak-grove, elm-grove, black poplar-grove and white poplar-grove as well as the considerable part of the river's stretches with wintering holes and spawning grounds.

The protected area should involve the river islands, places for nesting and habitation of big birds of prey, first of all, some species of eagle; a former riverbed with the relict plants (*Trapa natans, Salvinia natans)* and also the habitat of the Russian muskrat.

The area of regulated recreation (tourism and short-time rest) should include the considerable part of the designed national park, i.e. floodplain forests and meadow lands, a former river bed and sandy beaches. Being both a reserve and a special rest zone, the establishment of the national park “Ural'skaya Urema” will allow not only to preserve the valuable Ural landscapes, but to make it accessible to people.

Taking into account the unique peculiarities of the Ural basin and the natural-resource potential of this territory, the need for the creation of integrated joint venture for management of natural resources in the basin is brewing.

Based on the ecological-geographical analysis of the area of the Russian-Kazakhstan border, it may be suggested that the purposeful and legal management of the boundary regions will permit the solution of the following ecological-geographical problems:

- Using the effect of high landscape and biological diversity in the boundary territories, to promote the further development of the intergovernmental ecological net (EECONET), including the important objects of nature conservation framework, and the conservation of rare flora and fauna species through the harmonization of national and regional Red Books;

- To create the transboundary natural territories (reserves, national parks, recreational areas). It is especially important for the sectors of the state boundary with dynamic landscapes of the river valleys;
- To elaborate the international programs for restoration of the reproduction of valuable species of animals, namely, hunting and fishing;
- To develop a net of interstate stations for ecological monitoring of desertification, the indication of natural complexes change due to anthropogenic factors, the control of transboundary transport and migration;
- To resume the activity of the intergovernmental Committee on the problems of the Ural basin;
- To promote the development of the international ecological and boating tourism

The paper is prepared as a part of the integrated project of SB and FEB RAS 'Environmental risks in transboundary river basins: problems of interstate and interregional cooperation'.

References:

1. A.A.Chibilyov, The Ural basin: history, geography, ecology// Yekaterinburg: UD RAS, 2008. 312 p.
2. A.A.Chibilyov, Zh.T.Sivokhip, The Ural-Caspian transboundary basin: current geoecological conditions and prospects for Russian-Kazakhstan cooperation // Modern problems of arid and semi-arid ecosystems in the south of Russia: Book of papers / Rostov-on-Don: Publishing House of SSC RAS, 2006. pp. 290-301.

International basins of asia: is it a scene of conflicts or cooperation?

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Abstract Conflict situations in the international river and lake basins of Asia generated by the water factor are considered. All the situations are classified into four groups, namely, territorial, water-management, ecological, and natural-resources ones; their mapping was carried out. The examples of the situations and the ways of the problems solution are given. The experience of international cooperation on joint water management in Asian basins is represented. It is shown how the basin concept calls for the establishment of the uniform management regulations for the entire water catchment area.

ENVIRONMENTAL FLOW STUDY IN CHINA FROM 2000 TO 2009

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1. INTRODUCTION

Since the 20th century, there has been a rapid development of China's economy. Water use by industry, agriculture and domestic use has been in sharp contradiction to the water (ecological) use for environmental protection of the rivers, which has already caused many environmental problems. At the time one sees happily the quick social development benefit from water use, one also has to swallow the bitter resulted from irrational water use and face a series of severe ecological problems related to water in China. Examples are such as the seasonal dry-up of the lower reach of Yellow River, the bad appearance of the Wei River, one of the main tributaries of the Yellow River, which now looks like a pollutant-drainage, the shrinkage of wetland in the Hai River, the blue algae blossoming of the Han River and Tai Lake in the middle and lower reach of the Yangtze River, and the burst of the Songhua River water pollution event and among others. To solve these problems it needs the conduction of scientific research, establishment of legal institution and other confinement aspects. Among them, how to estimate the essential water for rivers and water bodies, i.e, environmental flow (EF) study, is a very important aspect.

China's EF study was conducted not as early as in other countries in the world. One of the first articles on EF in China was published late in 1980s (Tang, et al. 1989). It has not become a hot topic in scientific, technological and managerial fields in the country until the new 21st century. Since then there have been many documented researches on environmental flow (EF) study in China .

In this article, we will briefly review the advance of the EF study in China from the definition of EF and the methods to estimate EF in this decades. And some discussions on the general features of EF study in China, the hot study areas and international cooperation are given.

2. MATERIALS AND METHODS

The materials of this review are based on the articles published both national and international from 2000 to 2009. Besides reviewing colleague's work, the main results in author's group are also generalized. The methods used include simple comparison and brief generation.

3. Observations

The study on the definition of EF in China

Over the past decades, the definition of ecological water demand has been discussed widely in the following three ways (e.g. Liu, 1999; Cui, 2001; Wang et al., 2002; Su and Kang, 2003; Song et al., 2003; Shao et al., 2004; Xu et al., 2004). First, the definition of EF still has not been very clear yet. A relatively clear point, which has been widely accepted, is that there is a need to differentiate water requirements by ecological system and environment. The former mostly refers to the water needs for natural ecological habit and the later refers to the water for alleviating water pollution resulted usually by human activities. Second, unlike the previous thinking of the concepts of EF just focusing on minimum flow, now more and more people in China recognize that EF is the flow regime, which includes floods, average flows and droughts, for a river to maintains some desired ecological conditions, including aspects of physical, chemical and biological components and their interactions. Third, as the same as in other countries, several synonyms have been used here and there, such as Ecological Flow (EF, Liu et al., 2007a), Ecological Instream Flow Requirements (EIFR, Liu et al, 2007b), Ecological and Environmental Water Requirements (EEWR, Jiang et al., 2006). It is hard to get a unified term to describe it. In this manuscript, except when citing some papers, we always use Environmental Flow (EF), the most popular words in the world to describe water needs by both ecological system and environment.

3.2 The methods of EF estimation used in China

For the methods to estimate EF, those prevailing methods, which need not much data, are very welcome in China, such as Tennant method and wetted perimeter method. The applications of these methods are very wide. The complicated habitat techniques, such as in-stream flow incremental methodology, building block methodology and holistic method, which need very detailed ecological data, have very limited applications in China at present

Besides using the international methods, Chinese scientists are interested in proposing new methods and revising existed methods estimate EF. The reason is that there has not been enough ecological data for the estimation of EF in China. Several internationally popular methods do not fully fit the Chinese rivers. Liu et al. (2007a) defined the concepts of ecological flow velocity as well as ecological hydraulic radius (EHR) and proposed an ecological hydraulic radius approach (EHRA). This new method considers both the watercourse information (including hydraulic radius, roughness coefficient and hydraulic gradient) and the required stream velocity necessary for maintenance of certain ecological functions all together. The key parameter of EHRA is to fix the watercourse cross-sectional flow area corresponding to EHR, by which the relation between parabola shaped cross-sectional flow area and hydraulic radius is deduced. The EHRA not only meets the requirement of flow velocity for adequate fish spawning migration, but also is applicable to the ecological flows in regard with other ecological issues (such as the calculation of the instream flow requirements for transporting sediment and for pollution self-purification, etc.). In the same year, Liu et al. (2007b) proposed a new approach for estimating ecological instream flow requirements (EIFR) based on the relationship between the Life Habit and

Flow Variation, simply called LiHaFloVa method. The advantage of the method taken over to others is its skillful establishment of the relationship between the flow variation and the life habit of the key ecological protection goals based on investigated data. After identifying the key ecological protection goals and their key stage months corresponding to the valley (relative minimum) of the seasonal variation of the coefficient variation (CV) of the discharge, EIFR is calculated in two part s. One is for the non-key stage months, which is the product of 90% exceedence flow and the minimum value of CV over the year. Another is for the key stage months, which is the product of 50% exceedence flow and the CV in the corresponding month. The same group (Liu et al., 2006) also proposed an analytical solution of the minimum ecological in-stream flow requirement (MEIFR) under the assumptions of triangular cross section channel and uniform stable flow. Based on the analytical solution, the uncertainty of the wetted perimeter method is analyzed by comparing the two techniques for the determination of the critical point on the relationship curve between wetted perimeter, P and discharge, Q. It is clearly shown that the results of MEIFR based on curvature technique (corresponding to the maximum curvature) and slope technique (slope being 1) are significantly different. On the P-Q curve, the slope of the critical point with the maximum curvature is 0.39 and the MEIFR varied prominently with the change of the slope threshold. This indicates that if a certain value of the slope threshold is not available for slope technique, curvature technique may be a better choice. All of the above three new/revising methods are applied to the donating rivers in the Western Route South-to-North Water Transfer Project in China and have made useful suggestions for the decision-making of the project.

Discussions

4.1 EF study on large-scale catchment in China

One of the prominent characteristics of Chinese EF study is focusing on large-scale catchments. As China is a so big country, the rivers with EF study usually are in large scale. For a large catchment, it is very hard to conduct very detailed EF study as the same as many excellent overseas EF study in the world. Therefore Chinese scientists have designed some framework of water budget to deal with these challenges considered the requirement of water by the rivers, lakes, wetlands, vegetation and groundwater mainly applied in Hai Luan River, lower reach of Yellow river and its delta, and Liao River (see Li et al., 2000; Cui and Yang, 2002, Shi and Wang, 2002; Yan et al., 2002; Liu et al., 2004).

4.2 Conjunctive study of EF study on both water quantity and water quality

Furthermore, Chinese scientists have paid much attention to the integrated evaluation of EF related both water quality and quantity. Xia et al. (2005) addressed the concept of the available useable water resources related to both water quality and quantity and developed an integrated assessment model and method of water quality and quantity applied to single river section and multiple sections in a river system and basin with the application in Luan River. Wang et al. (2007) discussed the meaning of the quantity and quality of environmental flows of river in dualistic water cycle and compared with the meaning of unitary water cycle. Based on the analysis of the relationship between environmental flows of river requirements, the efficiency of water resource usage, the consumption coefficient, and the concentration of waste water elimination, the water quantity and water quality calculation method of the environmental flows of river requirements in dualistic water cycle is developed, and the criteria for environmental flows of river requirements are established, and therefore the water quantity-quality combined evaluation of natural river flows requirements are realized. By applying this method in the Dong Liao River, it is seen that the water quality is the main factor that determines whether the environmental flows can meet the river ecosystem demands.

The hot study area of EF research in China

Reviewing the whole of EF study in China, it is seen that almost all the seven big catchments, called Songhua and LiaoheRiver Catchment, Haihe and LuanheRiver catchment, Yellow River catchment, Huaihe River Catchment, Southeast Catchment, Pearl River Catchment, Yangtze River Catchment, Southwest catchment and Continental catchment□ have already conducted EF research. However, the hot regions so far mainly focus on the ecologically and environmentally fragile zones. The example is such as the Yellow river delta, Lower reach of Yellow river and Hai river. Hai River, for example, is now facing the so-called “three all” severe situations, as “all the river are dry, all the river are polluted and all the rivers are smelled four”. Another type of hot regions of EF study is in the places where the very important hydraulic is and to be going undertaken, such the donating rivers in the western, middle and eastern route of south-to-north water transfer project in China as mentioned earlier in this article.

4.4 International and within-national cooperation

It can be seen that Chinese scientists have made distinguish progresses on EF as listed above., However, not so many overseas EF experts so far recognize it. There are some papers as mentioned above written in English and some reports as the news focus (Stone and Jia, 2006) to introduce, but far not enough. Although many international resources on EF can be reached via journals, internet, conferences, books and so on, still not so many Chinese know the advances of EF study abroad due to language obstacle and other aspects. There is a strong appeal for further and wide cooperation.

Among the few international cooperation, worthy to mention is several cooperated projects and conference on EF. One of the very important international projects is that with Australians from 2007 to 2009 leaded by Profs. Changming Liu and Jun Xia in China side. Another is the cooperation between Dr. Suxia Liu and Dr. Chris Gippel in Fluvial Consultancy Company on the relationship between amphibian habitat and river flow regime from Jan. 2007 to Dec. 2009 funded by Chinese National Natural Science. The project within the Sino-Dutch cooperation program on water management on Yellow River Delta Environmental study was conducted from Oct. 2005 to Sep. 2007. EF has been the main topics in the national and international conferences held in

China over the recent years, including the Western Pacific Geophysics Meeting (WPGM) held in Beijing, July 24–27, 2006, Earth System Science Partnership Global Environmental Change Open Science Conference held in Beijing, 9-12, 2006; Eco Summit held in Beijing, May 22-27, 2007; the GWSP workshop held in the 2007's International Yellow River Forum, October 16–19, at Dongying City, Shandong Province, China, The working group conference of environmental flow, June 15-16, zhengzhou, 2008, and the Symposium of Ecological modelling for environmental flows in the Conference Internation Society of Ecosystem Modelling on "Ecological Modelling for Enhanced Sustainability in Management", October 6- 9 2009, Québec City, Canada,convened by Prof. Z. Yang.

The research on environment water flow is still at preliminary initials in China. We welcome more and more international and within-national contributions via IAP and all other channels.

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References

Cui Shubin. (2001). A research on issues of water demand for ecological environment. China Water Resources, 8: 71-75. (in Chinese)

Cui, B.S., Yang.Z.F., (2002). Water consumption for ecoenvironmental aspect on wetlands. Acta Scientiae Circumstantiae 22(2): 219-224.

Jiang Dejuan, Huixiao Wang and lijuan Li. □2006□. Progress in Ecological and Environmental Water Requirements Research and Applications in China, Water International, 31(2): 145–156.

Li Lijuan, Zheng Hongxing (2000). Environmental and ecological wate Haihe-Luanhe basins. Acta Geographica Sinica, 55(4): 495-500. (in Chinese)

Liu C, Men B, Song Jinxi.□2007a□ An ecological hydraulic radius approach to estimate the instream ecological water requirement. Progress in Natural Science, 17(3):32-39.

Liu Changming. (1999).The analysis of China's water supply and water demand in 21st century. China Water Resources, 10: 18-20. (in Chinese)

Liu Suxia, Jun Xia, Xingguo Mo, Zhonghui Lin, Changming Liu, Xiaobo Xuan, Chunhua Wu. (2007b). Estimating Ecological Instream Flow Requirements for the Donating Rivers in the Western Route South-to-North Water Transfer Project in China Based on the Relationship Between the Life Habit and Flow Variation. South-to-North Water Transfers and Water Science & Technology, 5(5):12-21

Liu Suxia, Mo Xingguo, Zhu Yonghua, Huanghao (2004). A new method for ecological water consumption calculation and application in Huaihe River Basin, Journal of Natural Resources, 19(5):662-671 (in Chinese).

Liu Suxia, Xingguo Mo, Jun Xia, Changming Liu, Zhonghui Lin, Baohui Men, Lina Ji.2006 Estimating the minimum in-stream flow requirements via wetted perimeter method based on curvature and slope techniques. J Geographical Sciences. 16 (2):242-250

Liu Suxia, Xingguo Mo, Jun Xia, Changming Liu & Lina Ji. (2008). The uncertainty analysis of the wetted perimeter method via axis scaling for setting minimum ecological in-stream flow requirements. IAHS Publ. 322: 193-198

Futrell, W. 2008, 2008-07-28 "Transnational Environmental Flows and Networks: Sandstorms, Biodiversity, and NGOs in Northeast Asia" Paper presented at the annual meeting of the Rural Sociological Society, Radisson Hotel-Manchester, Manchester, New Hampshire. 2009-05-23 from http://www.allacademic.com/meta/p254935_index.html

Richard Stone and Hawk Jia, 2006 News Focus, Hydroengineering: Going Against the Flow, Science, 25 August: Vol. 313. no. 5790, pp. 1034 - 1037 DOI: 10.1126/science.313.5790.1034

Shao Hongbo, Liang Zongsuo, Shao Mingan. 2004. Some advances in the study of eco-environmental use of water. Journal of Arid Land Resources and Environment, 18(3): 97-102(in Chinese).

Shi, W., Wang G.Q.2002 Estimation of ecological water requirements for the lower Yellow River. Acta Geographica Sinica 57(5): 595-602. . (in Chinese)

Song Jinxi, Li Huaien, Wang Boduo.2003. Summary on research of ecological and environmental water requirement of river. Journal of Soil and Water Conservation, 17(6): 95-98(in Chinese).

Su Xiaoling, Kang Shaozhong.□2003□ Concept of ecological water requirement and its estimation method. Advances in Water Science, 14(6): 740-743 (in Chinese).

Tang Qicheng. (1989) The water resources and oasis construction in Tarim basin. Natural Resources. (6):28□34 (in Chinese).

Wang Xiqin, Liu Changming, Yang Zhifeng. (2002). Research advance in ecological water demand and environmental water demand. Advances in Water Science, 13(4): 507-514. (in Chinese)

Wang Xiqin, Zhang Yuan, Liu Changming. □2007□Water quantity-quality combined evaluation method for rivers' water requirements of the instream environment in dualistic water cycle: A case study of Liaohe River Basin. J Geographical Sciences, 3:305-316.

Xia Jun, Wang Miaolin, Wang Zhonggen, Niu Cunwen, Yan Dong.(2005) An Integrated Assessment Method of Water Quality & Quantity Applied to Evaluation of Available Water Resources. Journal of Natural Resources, 5:752-760 (in Chinese)

Xu Zhixia, Chen Minjian, Dong Zengchuan. □2004□.Comments on calculation methods for river ecological water demand. Journal of Hohai University (Natural Sciences), 32(1): 6-9 (in Chinese).

Yan, D.H., Y. He, W. Deng, and J.D. Wang. (2001) Ecological water demand by river system in East Liaohe River basin. Journal of Soil and water conservation 15 (1): 46-49. (in Chinese)

Water Resources of Uzbekistan: Problems of Their Use in Present Water-Shortage

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Water is the most valuable natural resource in Central Asia. It is especially important for the Republic of Uzbekistan, which is situated in the area with natural low humidity, i.e. arid land. Located in the Central Asia and having, globally, one of the least water supply rates, Uzbekistan has completely utilized all, though scarce, available water resources. Current shortage of water resources is aggravated due to their quality deterioration. Therefore, water resources of Uzbekistan, like any other resources, should be viewed not only in the context of environmental significance but also, if not even more, be based on economic value; they determine livelihood of the population.

Uzbekistan is an arid (very dry) country and its water resources limit socio-economic and environmental development and, consequently, are recognized as a strategic resource. Eventually, to improve the population welfare and hence control migration in Uzbekistan, efforts must be focused on improving water resources quality and quantity management, that primarily means meeting drinking water supply requirements and water quality standards, improving land productivity, and reducing non-production losses.

Water resources, like any other resources, are in its greater hypostasis not only environmental category but rather economic one. In Central Asia, they gained such importance back to the ancient times, some 6-7 000 years ago, i.e. with introduction of irrigated farming practices. By the early 20th century, when the industrialization started developing in Central Asia and particularly in the construction sector, virtually half of the river-flow was used for irrigation. These processes completed by the 90ies of the last century. It is necessary to stress, that development of river water and power resources was implemented following specially–designed programs. As a result of this implementation, there was a complete utilization of all water resources in the southern part of the Aral Sea basin and its (the sea) destruction as a morphological and environmental component of the region.

Surface runoff

The bulk of Uzbekistan water resources is composed of surface runoff, which is formed by such transboundary rivers as the Syrdarya and the Amudarya as well as their feeders, and also Kashkadarya and Zaravshan Rivers. The major water flow of Amudarya River is formed in Tajikistan while that of the Syrdarya is formed in Kyrgyzstan [3].

The Syrdarya River Basin. Total area of Syrdarya river is about 345 000 km^2. The river is formed by junction of Naryn and Karadarya rivers; it is 2,800 km long, including the mouth, with its 2,000 km flowing beyond Uzbekistan. Nourishment of the Syrdarya and its feeders is of snow-and-glacier type. The Syrdarya water resources stand for, on average, 38.7 km^3. The bulk of the flow (about 70%) is formed in the upper part of the basin before leaving the Fergana Valley. Most of feeders come from the left side, within the Fergana Valley; from the left side, a lot of sais (gullies) debouch into it, but the flow is rather insignificant. After the Fergana Valley, the Syrdarya, the feeders debouch from the right side.

The total estimated surface inflow that comes to the Fergana Valley from the mountainous area of 94,000 km^2 is about 26.6 km^3/year. Its biggest share is supplied by the Naryn (45%) and Karadarya (16%); both the left and right side feeders give 39%.

The Syrdarya flow significantly fluctuates both during a year and within multi-year periods; average multi-year flow up to the Chardara water-reservoir that stands for 35.8 km^3, reduces till 24.3 km^3 during the low-water period. The natural flow regime is greatly distorted due to irrigation intake, drainage water discharges as well as that of the water-reservoirs that interfere with its hydrodynamics and hydro-chemical structure.

Chirchick River, the largest right hand feeder of the Syrdarya, is formed by junction of Pskem River, Ugam River and Chatkal River. The area of the Chirchick water collection is 14,240 km^2. It is a snow-glacier fed river; its highest flow takes place in July (581 m^3/sec.), the lowest is in February (69.1 m^3/s), the average year flow stands for 238 m^3/s. The water is supplied into the major irrigation canals (Bozsu, Karasu, Parkent).

The Amudarya River Basin. The Amudarya is the largest water-bearing river, which flow makes up 2/3 of the total Aral Sea basin water resources. The Amudarya is 2,540 km long, running from the Pyandzh to the Aral Sea; its 1,000 km flow within the Uzbekistan territory. Its basin covers a vast territory (about 1,327 thousand km^2). The river that results from joining Pyandj River and Vaksh River is called the Amudarya. Afterwards, it runs along the border between Afghanistan and Uzbekistan, then across Turkmenistan and flows into the Aral Sea, forming a huge delta 300 km wide. Two large feeders (the Kafirnigan and Surkhandarya) feed the Amudarya from the right and another one (the Kunduz) from the left. Farther, as far as the Aral Sea shores, there are no other feeders.

The river in its course crosses the deserts and semi-deserts, becoming a dividing line between two deserts: the Kara-Kum and Kyzyl-Kum. At the plain between Kerk and Nukus the Amu Dary loses the most of its flow due to evaporation, infiltration and irrigation intake.

The Amudarya is one of snow-glacier fed rivers; its water resources stand for 72.69 km^3. The bulk of the flow (85%) is formed by the Vaksh and Pyandj, while the Surkhandarya, Kofirnigan and Kunduz account for about 15%.

Total estimated surface flow that comes from the catchment–basin exceeds 80.5 km^3. The annual fluctuation rate against the multi-year pattern is not very large (variation coefficient is 0.15), but there is a marked irregularity within a year distribution: April to September takes 77-80 %, while December-February only 10-13 %. This pattern of the within a year distribution is rather favourable for irrigated farming.

The Zaravshan River Basin. The vast territory of Zaravshan river basin takes up 143 000 km^2. The mountain part of the basin runoff is formed by the Zaravshan River (51%) and its feeders (the Fan Darya and others). The river is 576 km long. Average multi-year flow is 4.82 km^3, and only 0.76 km^3 are formed within Uzbekistan country borders. The Zaravshan water basin is the least water-supplied region of the right bank of the Amudarya, that badly requires natural supply of its own water resources and water quality improvement.

Kashkadarya River flows down from the western part of the Zaravshan and Gissar mountain range and is 310 km long. Catchment area of the basin of the river Kashkadarya is 8,780 km^2. Such rivers as the Ak- su, Yakabag, Tankhaz and Guzar provide the major input into the formation of the river flow starting from the mountains to the Karshi oasis. Guzar River that flows into the Kashkadarya right before the Karshi oasis has a tiny water encatchment rate and quite irregular annual flow rate. The average multi-year flow of the Kashkadarya is 1.41 km^3. Not all rivers of the Kashkadarya water basin have a stable transit flow due to the intensive water intake from the river for irrigation.

Socio-economic development of the region after the World War II was pursuing complete utilization of the irrigation capacities of Amudarya River (~4.3 million hectares) and Syrdarya River (~3.0 million hectares). For these reasons, river flow was mainly controlled to meet the irrigation needs. By the 90ies of the last century, the flow control rate for the Syrdarya – Narin was as high as 92%-94% of the “standard” rate, while the water yields of 32-33 km^3 a year was ensured during 90 years of the century. The “standard” rate of the Syrdarya River is roughly 37±2 km3/year. The figures of the controlled flow for the Amudarya are a little lower (80-85%) with the standard rate being 75 ±4 km3/year, and the ensured water flow with 90% water supply in the midstream is closer to 60÷64 km3 .

The complex hydraulic facilities have been designed to use the hydroelectric potential. The hydroelectric potential in the region, at an achieved level of technological development, is estimated as 580-590 thousands HWt/hour. The major part of this (over 50%) belongs to Tajikistan and Afghanistan (over 50%); 25% to Kyrgyzstan; 15% to Uzbekistan; 4% to Turkmenistan; and 3% to South Kazakhstan [1, 2]. The economically accessible part of the hydroelectric potential equates to about a quarter of its value, and only about 60% of the hydroelectric power has been used so far. In the long term, taking into account the expected increases in the cost on energy resources, the economically accessible part of the hydroelectric potential will become equal to the technically utilized portion, and this will amount to 50% of its value. Taking into account the current prices for electric power, its annual output can be estimated as $5-10 billion US dollars. However, this potential still needs to be developed at approximate cost of 800-1000 US dollars per 1kW. The use of hydroelectric potential will allow the whole region to satisfy the major part of its needs in electric power demand using renewable resources. However, it should be noted that presently, the contribution of the irrigated agriculture into the gross domestic product of the region is ten times higher than the contribution expected from hydraulic power development.

It is shortage of water, especially in irrigation (since 90 % of water resources are used for irrigation) that lies behind the need to encourage agricultural water users to develop motivation of effective consumption, that is based on perceiving the idea of water as major source of wellbeing for most population of Uzbekistan.

About sixty percent of Uzbekistan rural population is employed by agricultural sector. That is why its efficiency is especially important since the fertile soil has served as a foundation for the wellbeing of the working population. The total area of arable lands is 44, 4057 million hectares and only 4, 275 million hectares of which are actually used.

The irrigated farming of Uzbekistan is a huge complex of sophisticated engineering facilities that includes 61 extensive water-reservoir of 15 billion m3 of total capacity, 46,668 trans-farms and 175,000 inter-farms hydro-hubs, 165,463 km of inter-farms irrigation canals, where 23,768 km in concrete trays and pipes; 29,786 km of inter-farm collectors, 104,433 km of inter-farm drainage and discharge networks including 42,734 km of sheltered horizontal drainage, 3,645 km of vertical drainage. Out of 4.22 million hectares of arable lands, 2,038 million hectares are irrigated by large and medium powered pump stations.

Proceeding from the above mentioned we can see that irrigated farming, which is the major and traditional environmental niche of the Uzbekistan population, considering the current technological development, has reached its limits. Surface water sources are exhausted; it means that water resources of all the Aral Sea basin rivers are fully implemented into the economy of the region.

The exhausting the Aral Sea Basin Rivers affected their water quality. While in the midstream fresh water is still available, in the down stream fresh water is only available during the high water, while in low water years it is slightly salty (1÷2.5%). Such unfavorable changes of the water quality even more aggravate soil salinity and make farming more water-demanding.

In general, water sources of Central Asia and their resources have served for Uzbekistan population as a basis of the economy and formation of socio-cultural practices, traditions and lifestyle for many centuries. This factor lies behind the importance Uzbekistan is attaching to the development of fair and rational water relationships in Central Asia.

Environmental Situation and Crisis of the Aral Sea

Environmental impact of industrial use of water resources is found to be negative, and its major result comes into the destruction of the Aral Sea. However, economic consequences include 200-300% expansion of irrigated land and harnessing hydropower resources. In the context of high population growth rate that happened in the 20th century, we can hardly have a negative view on the socio-economic impact of irrigation escalation.

However, we so far have failed to address the major challenge for the economy of the region, namely, unacceptably inefficient water use that is becoming especially critical considering local arid environment.

Development of the independence statehood of Uzbekistan started in extremely complex socio-economic and environmental conditions. Water management of the country and all water consuming sectors of the economy, its infrastructure were assessed as problematic, if not critical. The situation in the Aral Sea region was, actually, out of the people's control. The Aral region became the zone of ecological catastrophe of the global scale. The whole Aral Sea basin is marked with desertification of slough and maritime river deltas, complete disruption of naturally balanced ecosystem, aggravation of health status of practically the entire population and signs of the nation gene pool alternations.

Before the disruption of the environmental balance, the Aral Sea water level had been of 53 m high, the amount of water had stood for 1,064 km^3 with the water surface of 66 thousand km^2, the minerals content used to be about 10-11 g/L. By now, the water level has plunged to 37m, the amount of water is 270 km^3, the water surface does not exceed 30 thousand km^2, and minerals content is over 40 g/L. As a result, winter temperature rose by 1.5-2.5C^0 while summer got much hotter and vegetation period became from 10 to 15 days shorter. Hundreds of water reservoirs and lakes dried off, numerous branches of the Amudarya and Syrdarya disappeared with their flora and fauna got extinct. The environmental condition is highly tense. Due to the complete Aral Sea crisis the man-made pressing on the environment is escalating. The water resources are not always efficiently used. As a response to deteriorating quality of the environment, the number of diseases is increasing in environmentally unfavorable areas. The issues pertaining to the reduction of dangerous factors affecting the natural environment and human body, creation of conditions to ensure environmental safety are becoming the matter of state policy and one of prerequisites for sustainable development of the Republic of Uzbekistan.

The Republic of Uzbekistan is facing the pressing problem of shortage and pollution of water resources (both surface and subterranean). Rivers, canals, water reservoirs and subterranean water of the country are subjected to diverse anthropogenic influence.

The main water arteries of the country have become practically unfit for using for potable water supply due to the lack of systematic fresh water flushes and wash-water waste disposal from irrigated land with high mineralization, polluted with pesticides and mineral fertilizers.

The quality of the river water that comes from the mountains and their formation (within the territory of Uzbekistan) is quite high; this water is not polluted and its mineral content is pretty low. However, while moving downwards, the quality deteriorates. Most of the region rivers have a higher mineral content in their middle and down streams, within 1 – 1,5 g/L , in the mid stream up to 2 g/L and even higher in the down stream.

Conclusions

The fact that the Central Asian region, Uzbekistan in particular, is located in a single environmental space of a blind drainage area of the Aral Sea basin and has no access to the World Ocean in combination with arid climate, imposes additional and strict environmental restrictions on economic activity of the population. Development of irrigated agriculture in the Aral Sea basin surpassed the capability of the ecosystem and led to its destruction.

The measures, stated currently by the states located upstream of the main rivers in the Aral Sea basin, will exacerbate the socioeconomic conditions in the CA region and lead to ungovernable population migration from their historically habitable places of residence.

References

1. Diagnostic Report for Preparation of the Regional Strategy of Rational and Efficient Use of Water Resources in Central Asia/Special UN Program for the Economies of Central Asia. Project Working Group on Energy and Water Resources of the EEC UN, p. 74
2. Dukhovniy V.A., Sokolov V. I., Integrated Water Resources Management. Experience and Lessons of Central Asia on the Way to the Fourth Water Forum. Tashkent 2005, p.95
3. Makhmudov E.J.,Sherfedinov L.Z. Makhmudov I.E. Problems of water resource management in Central Asia. Transboundary Water Resources: A Foundation for Regional Stability in Central Asia. Springer 2007, Dordrecht, The Netherlands, p.11-28.

Management features of transboundary rivers water resources in Central Asia in the contemporary context

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Abstract. The article covers the current status of transboundary rivers use and management in the Central Asian region (CAR). It also considers the related problems and presents the positions of Kyrgyzstan and Tajikistan (as zones of formation of river flows) to address them. The impact of river flow regulation by reservoirs in Tajikistan and Kyrgyzstan on the entire CAR is estimated. It is shown that environmental, technogenic and economic impact is minimal. The article analyzes the results of the reservoirs' work in the irrigation and energy regime at this stage and in perspective, taking into account the national interests of Tajikistan and Kyrgyzstan. Basic principles of the Concept of water and energy resources effective use by the countries of the CAR are proposed.

Central Asia is a single region where water and hydropower resources are formed, in the main, by basins of the Amu-Darya, Syr-Darya and Sary-Jaz rivers. The volume of average annual flow of those rivers is about 150 km^3. In the zone of flow formation in the mountain areas of the Kyrgyz Republic and the Republic of Tajikistan, these rivers have enormous hydropower potential (about 10^{12} kilowatt-hour) but currently it is used with low efficiency. This is due to the fact that large reservoirs, constructed on the territories of Kyrgyzstan and Tajikistan, are used for the irrigation of lands mainly in Kazakhstan and Uzbekistan. This raises the problem of power supply for the countries-zones of flow formation, whose expenses, connected with operating those reservoirs, are not compensated by the countries-consumers of water, and that resulted in exacerbation of inter-state disputes. Countries-suppliers of water cannot fully use the power potential of their rivers, being forced to accumulate water during winter periods, in accordance with old international agreements. It is possible to solve these problems only by developing effective joint methods of managing water and hydropower resources.

In hydrological aspect, much of CA belongs to the Aral Sea Basin. Largest transboundary watercourses are the Amu-Darya and Syr-Darya rivers with average long-term runoff of 115.6 km^3/year. Formation of water resources of the Aral basin is presented in Table 1.

Table 1 Formation of the average long-term runoff in the territory of Central Asian states

Country	Basin of		Basin of the Aral Sea	
	Syr-Darya	Amu-Darya		
	km^3	km^3	km^3	%
Kazakhstan	4.5	-	4.5	3.9
Kyrgyzstan	27.4	1.9	29.3	25.3
Tajikistan	1.1	62.9	64	55.4
Turkmenistan and Iran	-	2.78	2.78	2.4
Uzbekistan	4.14	4.7	8.84	7.6
Afghanistan	-	6.18	6.18	5.4
Total	**37.14**	**78.46**	**115.6**	**100**

As for climatic conditions, this region is an arid zone, and guaranteed agriculture is possible only with irrigation, so the main water-consuming sector is irrigated farming. Large-scale development of water and land resources began in the 1960s. Union bases for the production of cotton and rice were established. The irrigated area reached 7.8 million hectares, and the volume of water used annually for this was from 95 to 107 km^3, depending on water content (Mamatkanov, 2005; Mamatkanov et al, 2006). In general, hydropower and land resources in Central Asia were distributed between states quite unevenly, and their use did not meet economic and environmental objectives. This led to an ecological catastrophe - degradation of the Aral Sea.

After the collapse of the Soviet Union, rapid development of market relations in agriculture led to 10-20 times reduction of the cost of maintenance and development of the complex water system, which includes irrigation and meliorative network. Since independence, national priority interests of some countries came into conflict with the interests of others. Mountainous countries with significant hydropower resources and limited land resources, suitable for cultivation, count on the development of hydropower with maximum water releases from reservoirs in winter periods - the periods of greatest power consumption. Without it they are doomed to weak economy and, consequently, slow development. Plain countries, with rich land resources but very limited water resources, want to receive water during the growing season, like it was in the Soviet Union in accordance with the mutually acceptable plan for development of agriculture and water economy of CAR. During that time, irrigation infrastructure was created on the plain lands of Kazakhstan, Turkmenistan and Uzbekistan for the production of high-yielding crops - cotton and rice. For this purpose, reservoirs of long-term regulation were constructed in the mountainous part of the region, in Kyrgyzstan and in Tajikistan, in order to ensure water supply and irrigation in the lower reaches of rivers. This approach determined the role of the mountainous republics as suppliers of water and caused insufficient development of irrigated farming, processing and fuel producing industries. As compensation, Soviet Union supplied missing agricultural products and power sources - gas, coal and oil - to these republics. Water resources of transboundary rivers were distributed between the republics depending on the number of irrigated areas, and, in general, the following quotas of water consumption were established in the Aral Sea basin (ASB) (in%): Kazakhstan – 10.4, Kyrgyzstan – 4.5, Tajikistan – 10.9, Turkmenistan – 23.1, Uzbekistan – 51.1. Under this scheme of water allocation, mountainous republics had the lowest water supply and the smallest number of arable lands per capita. So, if in Turkmenistan specific water consumption per person is

4044 m^3, and the irrigated area is 0.41 hectares, in Kyrgyzstan, these figures are, respectively, 1371 and 0.14, and in Tajikistan -1843 and 0.11 (Mamatkanov, 2006).

It is obvious that for the downstream countries water is a means of survival during summer periods. But water resources that are available today are not enough to ensure the power regime of reservoirs in the cold season for Kyrgyzstan and Tajikistan and to ensure irrigation regime in vegetation period for Kazakhstan, Uzbekistan and Turkmenistan. Such situation creates political, economic and environmental tension in Central Asia. Thus, it is necessary for all countries in the region to establish a fair system of water resources management; otherwise conflicts in water use will become permanent. Conflicting interests of the countries in the transboundary rivers basins, namely the change from irrigation mode to energy mode of reservoirs operation, have already caused catastrophic winter flooding, acute water shortages in the growing season, drying up of river terraces, discharge of huge amounts of clean river water into the newly formed lakes in the regional depressions (Sarykamysh in the Amu-Darya and Aidar-Arnasay in the Syr-Darya), and, at the same time, there is a huge deficit of clean drinking water in the region.

Downstream countries (Kazakhstan, Uzbekistan) are planning to construct new reservoirs to capture winter flood-flushes (Razakov et al, 2005). However, this costly technological measure would lead to additional losses of water due to evaporation from the surface of these reservoirs, it would take long time to implement, and there is no guarantee of consistent work of reservoirs in the future, and their little capacity would not completely solve the problem of water scarcity. Besides, the plan of additional withdrawal use of the Amu Darya by Afghanistan (2 km^3) and by Turkmenistan (120 km^3, for the construction of "golden sea") is being realized. We cannot say now how this will affect the Amu-Darya runoff management. One thing is clear: the runoff pattern of the river Panj, as well as of the Amu Darya, will change, which will make the problems of water allocation in the region even more complicated. In addition, uncontrolled water-releases from rivers and canals, especially in dry years, will create a crisis situation for the population living in the lower reaches of rivers and in the terminal areas of canals.

Today's problems stem from the fact that the formation of the sovereign states broke off all economic relations, and there were no more centralized subsidized supplies. Monopolization of natural resources and energy pricing at the world level exacerbated the already difficult economic situation in Kyrgyzstan and Tajikistan, the countries that do not have their own mineral resources and that are dependent on Uzbekistan, which supplies gas, and on Kazakhstan, which supplies coal and fuel oil. In 1992 in Almaty the Ministers of water economy of CA states signed an Agreement that preserves the old principles of water distribution in the Aral Sea basin until a new strategy for water distribution of transboundary rivers would be developed. 17 years have passed but this problem has never been solved, despite a number of agreements and declarations signed by the Heads of CA states on the need for concrete actions to regulate the system of water use and share holding in paying the costs associated with interstate water use.

In the new political and economic context, the mountainous countries feel that preservation of the old water distribution system is a manifestation of discrimination, because not only it impedes developing irrigated farming to meet domestic needs, but also imposes restrictions on the work of hydropower facilities. According to the Constitution and the Law "On Water" of the Kyrgyz Republic, water resources are the property of the state. The total volume of generated water is 50 km^3 a year but Kyrgyzstan can use only 11 km^3 for its own needs, which is less than 25%. The remaining water goes to neighboring states through the water-regulating structures. Kyrgyzstan has 3 million hectares of land suitable for irrigation, of which only 1 million is irrigated. In Tajikistan there is even less irrigated land – 0.8 million hectares. These figures are the lowest in the region.

In Tajikistan, due to poor quality of water resources management, only 57% of the population can use running water. And the consequences are alarming: nearly 25% of the population uses untreated water from ponds and canals. As there is a high risk of contamination and improper organization of sewage and fertilizers runoff, large part of the population is susceptible to diseases. The infant mortality is the highest here (78 and 93 cases per 1000 children of female and male respectively). According to a survey conducted by UNICEF, it was found that 45% of schools do not have clean water.

Shortage of funds and experienced specialists in hydropower has led to improper use of facilities and this, in its turn, has led to the fact that power systems in Kyrgyzstan and Tajikistan are operated at 60-70% of their efficiency instead of 90%. According to the World Bank, the irrigated area since 1991 has reduced around 18-20% due to the faults of the outdated irrigation infrastructure, and the area of vacant land is tens of thousands of hectares due to swamping, salinization and failure of the irrigation network (UNDP, 2003, 2009). At the same time, the amount of irrigation water used by Kyrgyzstan and Tajikistan should fit into the limits set by the Interstate Water Coordination Commission (IWCC) for each water economic year, which do not meet the needs of these countries.

On the other hand, erosion, flooding in the floodplain of the Syr-Darya because of the power mode of work of the Toktogul reservoir in winter; changes in river ecosystems; erosion of topsoil and loss of humus, nutrients and soil productivity as a result of deforestation in the upstream countries; loss of biodiversity at the basin level; rise in groundwater levels and consequent waterlogging and salinization of lands, which leads to growing number of environmental refugees; irrigation erosion; floods and mudflows in transboundary water bodies of joint use; change of natural hydrological regime of most rivers due to water withdrawal and regulation; siltation of reservoirs; loss of valuable agricultural land; global climate change - all these negative processes require immediate consolidation of inter-state adaptation activities.

Kyrgyzstan and Tajikistan are mountainous countries, and all sectors of their economies are concentrated mainly on 7-10% of the territory of valleys. At the same time, these countries form more than 80% of surface runoff of ASB, or 94 km^3/year (Table 1), using less than 20% of the runoff for their own needs. The countries upstream have minimal adverse environmental impact on water resources in the region, since most of those resources go to lower neighbors. For instance, Tajikistan takes only 0.4 km^3 (or 7.9%) of 5.05 km^3/year of the Zeravshan river runoff, the rest of the runoff – 4.65 km^3 (92.1%) – goes to Uzbekistan (Table 2) (Murtazayev, Saidov, 2008).

Table 2 Water resources of ASB for individual countries and their water withdrawal from rivers (2006-2007)

Country	Amu-Darya basin, km^3/year	Water withdrawal, km^3/ %	Syr-Darya basin, km^3/ year	Water withdrawal, km^3/ %	Total in ASB:		
					km^3/ year	% formative	% water withdrawal
Kazakhstan	-	-	4.5	8.16/181.3	4.5	3.9	181.3
Kyrgyzstan	1.9	0.45/23.7	27.4	0.28/1.02	29.3	25.3	24
Tajikistan	62.9	9.5/15.1	1.1	2.1/190.9	64.0	55.4	18.1
Turkmenistan	2.78	22.0/791.4	-	-	2.78	2.4	791.4
Uzbekistan	4.7	22.0/468.1	4.14/11.6	280.2	8.84	7.6	380.1
Afghanistan	6.18	-	-	-	6.18	5.4	-
Total	78.46/	53.95/68.8	37.14/22.14	59.6	115.6	100	65.82

As it is shown in Table 2, Turkmenistan, Uzbekistan and Kazakhstan withdraw the greatest amount of water from annual runoff (Turkmenistan takes 7.91 times more water than it is formed on its territory, Uzbekistan – 3.8 times and Kazakhstan -1.81 times). In 2006-2007 the remaining river flow in the amount of 39.5 km^3 was supposed to withdraw into the Sub-Aral area. Of this amount, 7.61 km^3 was withdrawn for the irrigation systems and environmental discharges, and 31.9 km^3 was withdrawn into the Sarykamysh and Aidar-Arnasay lakes where the water was essentially "locked", i.e. not used. Thus, Kyrgyzstan and Tajikistan fully comply with their obligations to supply water to the Aral Sea, however, this water does not reach the Aral Sea because of the actions taken by Turkmenistan, Uzbekistan and Kazakhstan and the senseless accumulation of water in new lakes.

In this regard, the upstream countries have the right to use their water resources, as required by their national interests. Thus, the construction of large and small hydropower plants on the rivers of Tien Shan and Pamir (domestic rivers of Kyrgyzstan and Tajikistan) requires the creation of reservoirs of daily flow regulation, small-sized and with small flooding areas. Construction of hydropower plants with reservoirs is important for all CA countries, because, besides electricity generation, they would provide not only themselves but also the downstream CA countries with irrigation water.

In Kyrgyzstan there are Ortotokoy and Kirov reservoirs for water supply to Kazakhstan and Kyrgyzstan, and Toktogul, Papan and Andijan reservoirs - for water supply to Uzbekistan, Kazakhstan and Tajikistan. During the construction of just Toktogul reservoir of long-term regulation, the Kyrgyz Republic lost 28 thousand hectares of farmland, 12 thousand hectares of irrigated land was flooded.

After Central Asian states gained sovereignty, all these reservoirs became of interstate significance, as they serve the interests not only of Kyrgyzstan. Meanwhile, Kyrgyzstan spends its own funds for their maintenance and repair, without receiving grants from the downstream states - water consumers. Work associated with monitoring, management, scientific research, reproduction and protection of water resources is funded from the Republican budget. The upstream countries are no longer able to keep on bearing the burden of hydrological monitoring and maintenance of water facilities of regional significance alone. All water consuming states should contribute to the maintenance. However, so far there was no reaction from the governments of these states. This is fraught with regional disasters.

An example of it is a Baipaza landslide in Tajikistan, which again intensified after the earthquake on March 3, 2002. The movement of landslide masses began on March 6-7, and by 13 March the landslide blocked the riverbed of the Vakhsh. It created a dangerous head in the tail-water of the Baipaza hydropower plant, threatening flooding the plant. Thanks to enormous efforts and the loan of the Asian Development Bank and "Barki Tochik", the riverbed was cleared within a month. In addition, special emergency measures to reduce the risk of reactivation of the landslide were developed and implemented by the end of 2004, and the technical and economic assessment of the construction of a bypass tunnel in case of repeated blocking was developed (Arifov & Arifova, 2005). Total costs amounted to $4 million. And Uzbekistan, Turkmenistan and Afghanistan did not participate in the financing of these measures, despite the fact that the reservoirs of Nurek and Baipaza power plants provide them with clean river water.

The Kyrgyz Republic sustains significant losses by operating Toktogul reservoir in the irrigation mode. The reservoir is an integrated energy irrigation object. In the vegetation period up to 80% of the annual runoff of the river Naryn was given to the lower reaches, and the hydropower plant worked as a peak load compensator in the Central Asian energy system, and, as noted earlier, in winter period the Kyrgyz Republic was supplied with coal, gas and fuel oil. After the supplies ceased and the energy prices reached the world level, Kyrgyzstan was forced to partially change the work mode of the Toktogul hydropower plant from irrigation to energy one. That caused negative reaction from the downstream states, as it had reduced water supply during the vegetation season and to flooding of land in the floodplain of the Syr Darya river in winter, due to the reduction of its capacity.

In Tajikistan the existing system of water energy resources management of the Kayrakkum hydropower plant in irrigation mode is discriminatory. According to an intergovernmental agreement, the balance of power transmission into Uzbekistan for the regulation of the Kairakkum reservoir runoff in the irrigation mode is minus 100 million kilowatt-hour. It does not take into account the fact that Uzbekistan does not pay for the services on river runoff management by the Kairakkum reservoir during 3 months of the vegetation season when the mutual transfer of electric power is going on, which is about $ 300 thousand per month or $ 0.9 million per vegetation season.

The same situation is with the Toktogul reservoir, providing long-term and seasonal flow regulation of the Naryn-Syr Darya Basin both for power supply in Kyrgyzstan and for irrigation in Kazakhstan and Uzbekistan. Compensation in the amount of 2.2 billion kilowatt-hours for the work in irrigation mode during the vegetation period, implying the payment for water shortfall in the volume of 2 km^3, is paid only to Kyrgyzstan (Valamat-Zade, 1999; Boltov, 1999). This is explained by the fact that Kayrakkum reservoir allegedly only transfers water, and it is of seasonal regulation. According to the accepted scheme of regulating the runoff of the Naryn - Syr Darya (17 June 1999), Tajikistan's interests are ignored, although the regulatory capacity of the Kayrakum reservoir is fully utilized. Seasonally, the Kayrakkum reservoir is filled during inter-vegetation periods and is worn off in vegetation seasons, thus making the main flow regulation for irrigation in Kazakhstan and Uzbekistan. The Toktogul reservoir in inter-vegetation period operates in the opposite mode.

Therefore, Tajikistan, which does not produce enough electricity in winter, experiences its severe shortage and has to buy electric power in Turkmenistan and gas in Uzbekistan (2.5-3.5 U.S. cents per 1 kilowatt-hour). And all this happens against a background of difficult financial situation of the national power system, low living standards and the collapse of most social programs. At the same time, Tajikistan can generate additional electricity of up to 1.5 billion kilowatt-hour in summer, but Uzbekistan and Kazakhstan do not agree to take that amount of electricity and return it in winter. The amount of seasonal transfer of electric energy to these republics is low - 200-250 million kilowatt-hour (slightly more than 1%) of total electricity generation (Boltov, 1999).

If Tajikistan refuses from the irrigation mode of the Kayrakkum reservoir, which is an extremely unfavorable mode, and adopts the energy mode, which is more optimal for the republic, the Kyrgyz Republic will have to increase releases from the Toktogul reservoir during the vegetation period by an amount equal to twice the amount of useful amount of the Kayrakkum reservoir (5.2 km^3) in order to maintain the level of irrigation in Kazakhstan and Uzbekistan. This, in turn, would lead to a new leap in the energy crisis in Kyrgyzstan, as it would have to accumulate water in the Toktogul reservoir in winter. To prevent this, Kazakhstan and Uzbekistan should compensate the cost of energy in an equivalent amount.

Since 1998, Kyrgyzstan, Kazakhstan and Uzbekistan sign agreements on the use of water and hydropower resources of the rivers Naryn – Syr-Darya every year. Under these agreements, during vegetation seasons Kyrgyzstan provides the necessary amount of water, while Kazakhstan and Uzbekistan receive electric power, produced as a result of irrigation water releases, in equal amounts (2 billion kWh). Payment is made not in monetary terms but through the energy supply. There are frequent breakdowns in such a system, and almost every winter the Kyrgyz Republic remains without gas and heat for domestic consumers. Annual losses from the work of the Toktogul reservoir in the irrigation mode are estimated at more than $ 150 million and include the cost of fuel to compensate hydropower under-runs in winter. We should also mention the significant environmental damage from the burning of fuel at thermal power stations.

There is also damage from the operation of the Kayrakkum (KKR) and the Nurek (NR) reservoirs in the irrigation mode in Tajikistan. For instance, the flooding zone of KKR is more than 10 thousand hectares, after its construction the area of fertile farmland was reduced by 54 thousand hectares. Environmental and economic damage to the area around KKR is estimated at $ 10.8 million (lump-sum costs of withdrawal of various items from the zone of flooding - $ 2.6 million; annual shortfall in agricultural products - $ 5.2 million; maintenance costs for 9 pumping stations to maintain an acceptable meliorative regime in this area - $ 1.7 million; costs of the reservoir operation - $ 1.3 million). These damages are also ignored and not compensated by the partner countries.

Nurek power station, functioning as a part of the interconnected power system, provides a stable voltage level in the networks of the Samarkand and Bukhara power units in Uzbekistan, and together with the Toktogul hydroelectric power plant in Kyrgyzstan it acts as a regulator of industrial frequency in the region. Moreover, the share of the Nurek power plant accounts for two-thirds of regulation of this important quality indicator. In 2005 alone the Nurek power plant provided frequency regulating services for Uzbekistan in the amount of 1705 and for Kazakhstan - 2142 MW. This resulted in the deviation in frequency of no more than 0.5% of the prescribed standard (50 Hz). Otherwise, damage to the partner countries would be $ 35.6 million. However, Tajikistan is not paid for these services either. Thanks to the water from NR, Uzbekistan cultivated 1.4 million hectares of land. Guaranteed water supply during the growing season increased yields not only on newly developed lands but also on the lands irrigated previously. In addition, reservoirs in Kyrgyzstan and Tajikistan protect and mitigate the possible negative effects of flooding, thereby reducing the losses of neighbors.

In this regard, proper water and energy policy becomes a decisive factor for the economic development of CAR, and the mode of operation of water reservoirs is of considerable importance. It is fundamentally important to negotiate and adopt a Concept of the efficient use of water and energy resources of CAR. This document must ensure regional stability, economic development and environmental security. Certainly, in terms of water and economic relationship in CAR, decisions on the exploitation of existing and putting into operation of new reservoirs should be taken very cautiously, taking into account national interests of all countries in the region. Water resources in the region should be re-distributed, taking into account the constitutional rights of independent states to their own natural resources. Interstate use of water should be based on an economic mechanism to compensate all costs and damages associated with monitoring, research, reproduction, protection of water resources, as well as with the water supply through water-regulating structures. States that receive water from Kyrgyzstan and Tajikistan must participate in the financing of all types of these works on a share basis through the establishment of water tariffs.

The planned Agreements on the Amu-Darya and Syr-Darya should include the following:

1. All CAR countries should prepare for gradual reduction of total water consumption from the basins of transboundary rivers proportionately.
2. It is necessary to clearly determine the amount of the calculated environmental releases from the basins and the measures for their control.
3. Addressing the issues of designing and financing the construction of hydropower complexes requires that all lower-lying countries, interested in this, either directly provided funding for these facilities or determined their share in the credits, which Tajikistan and Kyrgyzstan could take from international organizations for their construction. The future co-operation of cascades on the rivers should be guaranteed on the basis of shared financing, and that, in its turn, would ensure equitable and reasonable utilization of water resources and at the same time secured and timely receipt of necessary water and energy resources.
4. If the damages from the operation of the Toktogul, Kayrakkum and Nurek hydroelectric complexes are compensated (when operating in the irrigation mode), the downstream states will be provided with water when necessary and in the required amount.

To implement these initiatives, the Institute of Water Problems and Hydropower of the National Academy of Sciences of Kyrgyzstan has developed "The economic mechanism of management of transboundary water resources and the basic strategy of water allocation (Asanbekov et al, 2000), which proposed a methodological framework for assessing the value of water in various types of use. The following types of water tariffs were established: as a natural resource, given its quality and amount; for the services of water supply; for regulation of long-term and seasonal regulation in the reservoirs. The Institute developed a method to assess the damage from the Toktogul hydropower complex in the irrigation mode. On the basis of existing international documents, the Institute proposes provisions for a new modern strategy of water allocation, aimed at fair distribution of transboundary water resources, taking into account the constitutional rights of the republics to their natural resources.

Now these proposals are submitted to the Government of the Kyrgyz Republic, and the first practical step would be to establish the tariff for water as a natural resource. This would allow funding the monitoring, reproduction and protection of water resources at the expense of water users. Neighboring countries, paying the established tariff for water, would use water resources on a share basis, and, in addition, they would have access to hydrologic information on the flow formation and inflows into the reservoirs.

Such a mechanism would contribute to the rational and careful attitude to water resources by all the countries of CAR. Of course, this will require professional responsibility of researchers and exclusion of subjective assessments, especially in the context of water scarcity in the region on the current technological level of their use.

Thus, water and environmental problems of CAR require compromising approaches to their solution, gradual reduction of the contradictions in the positions of various countries on the basis of rational management of the transboundary rivers resources, using the developed economic mechanism.

References

1. ARIFOV H.O., ARIFOVA P.H. (2005). On compensation of additional expenses for the protection of mountain areas, the cascade of hydroelectric stations on the mountain rivers and guaranteed water supply to lowland regions//Collection of articles, Conference on regional cooperation in transboundary river basins, 3-5. Dushanbe.
2. ASANBEKOV A.T., MAMATKANOV D.M., SHAVVA K.I., SHAPAR A.K. (2000). The economic mechanism of transboundary water resources management and the basic provisions of the interstate water allocation strategy. MGI, Bishkek, 43 p.
3. BOLTOV V.V. (1999). Regulatory capacities of the Kayrakkum reservoir. Tajikistan's economy: development strategy, 3. Dushanbe: 92-97.
4. VALAMAT-ZADE T.G. (1999). Water resources: national and regional policies strategy. Ibid: 107-113.
5. Second national message of the Kyrgyz Republic to the United Nations Framework Convection on Climate Change (2009). Bishkek, UNDP: 214 p.
6. How to improve water management in Tajikistan. (2003) National Report on Human Development. Dushanbe, UNDP: 80 p.
7. MAMATKANOV D.M. (2005). Modern problems of interstate use of transboundary watercourses of Central Asia. Water and the market. Seminar Materials "Ecology and clean water (Issyk-Kul, 2002)" and "Water and the Market (St. Petersburg, 2003.)" Saint-Petersburg Polytechnic University: 199-204.
8. MAMATKANOV D.M, Bazhanova L.V., Romanovsky V.V. (2006). Water resources in mountainous Kyrgyzstan at the present stage. Bishkek: Ilim: 276 pp.

9. MURTAZAYEV U.I., SAIDOV I.I. (2008). Water Resources Management in Tajikistan and its impact on the Central Asian region (environmental, technological, economic). Works of the International Conference "Crucial problems of development of Central Asian states in market conditions". Dushanbe, RTSU: 144-156.
10. First National Message of the Kyrgyz Republic to the United Nations Framework Convection on Climate Change. (2008). Bishkek, UNDP: 98.
11. RAZAKOV R.M. et al (2005) Socio-economic and environmental damage at the existing state of water resources in the Aral Sea basin. Water and the market. Seminar Materials "Ecology and clean water" (Issyk-Kul, 2002)" and "Water and the Market" (St. Petersburg, 2003) Saint-Petersburg, Polytechnic University: 85-115.

The issues and prospects of monitoring and water resources use in Armenia

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The Republic of Armenia with a total area of some 29 800 sq.km is a highland country having semi-arid climate. 75% of her total area lies at a height of 1.500 m a.s.l. On some 60% of the territory the amount of precipitation is 600 mm, and on 20% - 200mm at the most.

Wholly, Armenia's river net accounts for 400 rivers with total extension of over 10 km. Predominant are small quick mountain rivers. Mean total river water runoff that forms within the bounds of the country, is 6.250 mln m^3/yr, 3.029 of which originate from springs and underground water drainage. There exist 14 large river basins in the country. Armenia's lakes lie high in the mountains and commonly are not large, but for the Lake Sevan. Presently, active are 74 water reservoirs constructed in different years. Their total capacity is 988 mln m^3/yr. 30 water reservoirs are under construction. After completion of construction it will be possible to additionally reserve 832 mln m^3 of water. Natural resources of Armenia's underground waters make some 4.0 mlrd m^3/yr, 1.595 of which are spring, 1.405 – drainage, and 1.0 – depth underground waters. All across Armenia, over 700 natural and artificial outlets of mineral waters are found.

With a view of meeting the requirement of Water Regulations, Armenia has adopted the laws "About fundamentals of the national water policy" and "About national water program".

In 2002 the Government of Armenia approved a program "Actions on developing agricultural melioration in the Republic of Armenia for 2002-2005" which pursued improving and maintaining fertility of farmlands and assuring high sustainable yield of farm crops.

In 2005 adopted was a RA law "About agricultural melioration" aimed to setting up powers of state bodies in the area of melioration and encouraging implementation of melioration actions.

Water use in Armenia is classified as drinking-domestic, irrigation, hydroenergetic, for the purposes of industry, recreation, fishery, etc. The major water user in the country is considered to be the agriculture sector. The basic pathway of development of agriculture in Armenia is melioration: irrigation, reclamation, flooding, etc.

The irrigation water use issues

Presently, the irrigation sector faces numerous hardships such as overall obsolescence of irrigation water supply networks resulting in 50% up to 80% of water loss, unmotivated costs for exploitation of pumping stations. Drainage-induced problems should also be noted particularly in relation to the Ararat Valley where underground waters outlet onto the surface.

To supply the rural populace with drinking and irrigation water, a set of tasks is to be managed. For example,there are high mountainous villages where pottering water is still delivered in tanks and irrigation water does not reach due to lack of necessary pumps. Substantial investments are needed to supply the population of such territories both with drinking and irrigation water.

Special attention is given to the unique natural freshwater reservoir – Lake Sevan. Presently, the lake is an ecosystem with disturbed biological balance. Since recent years the lake water level has been drastically increasing. The lake waters are actively used in irrigation. Unfortunately, some 50% of water released from the Sevan for irrigation are lost on the way. One of major reasons is the scattering of land parcels, every parcel being provided with separate irrigation canal. The increased volume of infrastructure increases the probability of water loss on this or that plot of land. The water loss is predetermined also by poor conditions of main irrigation canals and particularly those of Artashat, Hrazdan, Arzni-Shamiram.

Under support of the World Bank, Armenia has performed and is performing diverse projects aimed to the improvement of irrigation network. Presently in the frame of the Program "Millennium Challenges" in progress are extensive works on the improvement of irrigation network, recovery of drainage networks, transition to gravitation water supply, development of farms.

The drinking water use issues

Municipal water supply is considered to be the second major water user. Some 95% of municipal water is supplied from high quality underground water sources. Since recent years effective actions have been taken to improve water supply networks and to supply the population with good drinking water. Armenia is rich in fresh water sources and particularly springs underpinning today the basic drinking water supply to the people.

One of issues connected with drinking water quality is technical conditions of system. The topicality of the issue results from obsolete water supply network which for the present has been recovered partially. Of importance are works directly connected with deploying, protecting and managing drinking water sources. There emerges an extreme need to produce maps of location and reserves of underground, artesian and spring waters. It is necessary to update relevant databases, produce digital maps. It is necessary, too, to trigger investigations aiming development of innovative water cleanup technologies.

Hydroenergetics

The development of Armenia's hydroenergy potential implies construction and exploitation of small- and medium- capacity hydroelectric power stations, and since recent years this process has been intensifying. Mostly this is predetermined by favorable conditions existing in Armenia for construction. In compliance with the developed National Program on Saving and Renewing the Energy in the Republic of Armenia and with regard for her water resources (Rivers Debed, Aghstev, Akhurian, Hrazdan, Lake Sevan etc.) and their potential, the country can assure the work of 313 small hydroelectric power stations, which summary mean annual energy output will be 737.38 mln kW. The same Program plans construction of hydroelectric power stations in Meghri and Loriberd with a capacity of 140 and 60 MW, respectively, which summary yearly output will be 1028kW/ hr.

Though exploitation of small hydroelectric power stations as renewable energy carriers is not accompanied by emissions of harmful substances and greenhouse gases into the ambient air, nevertheless they substantially affect the water ecosystem of natural water reservoirs and particularly the fish.

In respect to large hydroelectric power stations one should note that their harmful environmental impact is much more stronger and according to the accepted international standards they unlike small hydroelectric power stations are not treated as a renewable energy source.

Fishery

In Armenia, fishery is developed predominantly on Lake Sevan. Commercial fishery is developed also in artificial ponds and reservoirs created mainly on saline lands of the Ararat Valley.

Presently, for this purpose about 135 mln m^3 of fresh water are used, some 30% of which evaporate.

Recreation

To some extent, almost all large rivers and lakes of Armenia are deployed mostly by local populace for a purpose of recreation.

The major water object of the Republic deployed by local population and foreign tourists for recreation is Lake Sevan surrounded by numerous hostels; in summer arrangement of temporary tents is also popular. Unfortunately, the problem of shoreline pollution with garbage has not been managed yet. Rather a high recreational potential of some river bank-adjacent sites has not been used either.

Sewage waters

At the moment, the condition of sewage water system in many settlements is poor. Some 63% of collectors and pipelines were constructed over 40 years ago. As a result of poor quality of basic repair and recovery works, obsolescence of constructions and equipment, lack of investments to resume the repair of old constructions, wastewater cleanup stations have almost collapsed. Today, partially active is only one of 20 cleanup stations operating in the past – The Yerevan aeration station.

In Armenia, some 400-500 mln.m^3 of waste waters (domestic, industry- and agriculture- induced) are discharged annually into open water basins.

Since 2003 the Government has focused on recovery of sewage water system and waste water cleanup systems. The performed technical-economic studies disclosed a need of large investments.

Water quality issues

Protection of the quality of Armenia's surface and underground waters has a strategic importance. The problem consists in poor organization of quality control, waters pollution with diverse toxic compounds and elements induced by developed mining production in the Republic, lack of cleanup facilities.

For water systems extremely important is protection and rehabilitation of biodiversity. In particular, the problems relate to lakes and artificial water reservoirs. In the first instance, of extreme importance is the recovery of Lake Sevan.

In specially protected areas diverse natural ecosystems are controlled and protected. As many water objects lie on the territories of reserves and national parks, so as a whole protection and water quality control is more effective there, despite some existing problems. For instance, the reserves Sev Lich created in 1998 which lies at a height 2658 m a.s.l. have no research database, and organizational, expert and monitoring works are not performed.

Cultivation of additional farm is often hampered not only by the scarcity of water resources but also by the lack of high quality irrigation waters. Though wholly, Armenia's river water are classified as satisfactory according to total mineralization level, nonetheless there exist certain problems. For instance, using low mineralized waters in irrigation may lead to gradual salinization of soils manifested in substitution of 2-valent ions for 1-valent in the exchange complex of soils. This deteriorates some physical properties of soil and particularly increases the level of its dispersion, plasticity, swelling, which results in soil structure degradation and loss of fertility. Salinization is mainly predetermined by transfer of Na from water to soil instead of calcium and magnesium ions which are washed out from the colloid phase of soil to soil solution.

The meliorated soils of the Ararat Valley, where the overwhelming part of Armenia's farm products is grown, the contents of calcium in composition of changeable cations reach 60-93% of the sum of bases; magnesium varies between 6 and 23%; the amount of exchangeable sodium varies 3-5%. This supports a conclusion, that rather high content of calcium and magnesium in soils may pose a serious threat of salinization as a result of exchange processes. There is also problems in connection with the use of waters polluted with heavy metals. Therefore, need to perform complex studies on the assessment of water suitability for irrigation. The problem of the quality of irrigation waters is very topical not only from a viewpoint of protection of soils but also in respect of assuring quality of cultivated farm crops.

The problems of water resource monitoring

Investigations, protection and sustainable use of water resources are based on monitoring data. So monitoring studies should be continuous, systematic, complex, with necessary frequency and priority. Taking into consideration the problems of monitoring and investigations, to assure sustainable development of the field, presently one finds it reasonable to

- assure transparency and accessibility of monitoring data,
- improve qualification and professional skills of specialists,
- create programs not only of background but also of pollution monitoring,

- expand and deepen studies of water ecosystem, providing complex approach
- develop transboundary monitoring databases,
- promote studies on developing the national quality standards of surface waters.

Presently, Environmental Impact Monitoring Center carries out continuous observations in the country. Alongside with it, over recent years regional projects were implemented, aimed to development of monitoring basis.

Among them:

- A project "Joint management of rivers – the Kura basin" which budget was 4 mln Euro, 2002-2004, is a good example of the practice of Helsinki Convention. The project pursues the development of monitoring systems of the South Caucasian countries and harmonization of their activities; monitoring strategy has also been worked out. In the frame of the project training courses were held on site and in the Netherlands for national water specialists. Lab equipment has been purchased by the laboratories of the three countries. The water regulations of the SC countries have been analyzed.

- A regional project of collaboration on river monitoring funded by NATO (Science for Peace Program) and OSCE "South Caucasus River Monitoring", 2002-2008, performed by the Center for Ecological-Noosphere Studies of the National Academy of Sciences of Armenia. The project activities involve Armenia, Azerbaijan, Georgia, Belgium, Norway and the USA. The project is aimed to water quality monitoring on 10 monitoring stations in each of the 3 countries of the region. Undertaken was a closer collaboration via national borders. The process of monitoring is required to plan water resources in the region in the future. A substantial project contribution was compilation of transboundary database on quality and quantity indices of the waters of the rivers.

Prospects of water resource rational use and management

Since 2004 in Armenia the process of transition to the basin planning of rivers including those transbpoundary has actively been running. Collaboration has been established along national borders with the involvement of local NGOs and active participation of women in the process of water resource management. One should note achievements on a technical level of hydro- and meteorological services, i.e. information exchange between the countries. USAID also supports the activities of the newly established Agency for Water Resource Management. The World Bank and Japan have also been involved in the process of water supply privatization.

Foreseen is activation of works on the development of technologies of integrated management of water resources in the basins of different rivers as a direction of development of basin management of water resources.

The RA Government have stated a task for the near future to considerably expand the areas of irrigated lands with a view of a sharp increase in production of farm crop. To reach this goal, a number of regions of the Republic plan to repair and reconstruct the operating water economy objects, which will allow to additionally irrigate hundreds of hectares of fields, orchards and hayfields presently deprived of irrigation. For these purposes in the frame of the program "Millennium Challenges" the World Bank allocate billions of dollars to our Republic. At the moment the works on the recovery of the Marmarik water reservoir are in progress; after putting it into action, it will be possible to substantially reduce water release from Lake Sevan for irrigation purposes.

Water reservoirs will be built in Yeghvard, Kotayk, Shirak and other regions.

In the frame of the National Program envisaged are and have already been launched works on transition from mechanic water supply for irrigation (through pumps) to independent irrigation, which will allow cutting expenses for electroenergy. Considerable attention is given to the account of the used water, too, which will allow consuming water in a more economical way. Special attention in everyday work is given to exploitation of the unique water system Vorotan-Arpa-Sevan, too.

Foreseen is execution of a set of projects under support of the Asian Development Bank pursuing improvement of drinking water supply to rural population especially on highland territories. In the frame of all the projects foreseen is reconstruction and construction of a drinking water network with a total extension of 60 km excluding connection to houses.

With a view of improving water supply, the World Bank will provide an additional 20mln credit line for Armenia intended for the improvement of a water supply network and waste water removal. In Lake Sevan basin works have already been initiated on construction of cleanup stations.

Armenia and Iran plan to build on trasboundary River Araks the most powerful hydroelectric power stations in the South Caucasus. Each of them will annually produce 800 mln kW/hr. To compare, I wish to state that Armenia's most powerful Sevan-Hrazdan cascade of hydroelectric power stations annually produces 500-600 mln. kW/hr of electroenergy.

In connection with a crucial situation connected with a drastic decrease of fish stock on the Lake Sevan, the Commission for Lake Sevan issues attached to the President of Armenia is preparing a suggestion on a three-year moratorium for fishing in the lake.

Great attention is given to the development of tourism in the country. Rest zones are being created around small but picturesque highland lakes, spa-surrounding territories are being equipped with necessary facilities to organize the rest and maintain the health of the population.

Problems and prospects of water resources utilization in Transbaikalia region

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The river flow of three watersheds (the Amur, Lena and Baikal) is formed on the territory of Transbaikalia Krai. There are 3956 rivers which length exceeds 10 kilometres, and 3500 lakes with the area exceeding 1 square kilometre. The total average annual flow of rivers is 65.4 kilometres, including the basins of: Amur river - 29.0 kilometres, Lena river– 28.9 kilometres and Lake Baikal – 7.5 kilometres. The volume of water concentrated in lakes exceeds 4160 million cubic metres [1].

There are 50 groundwater deposits in Transbaikalia. The useful resources of these deposits amount to 1523 thousand cubic metres per day, 1077.3 thousand cubic metres per day are prepared for commercial development. Ground water reserves of 15 deposits in the amount of 157.5 thousand cubic metres per day are taken into account.

The available water resources are sufficient to meet the demands of population and industry of the region. However it should be noted that the quality of natural water in Transbaikalia is constantly deteriorating. Tables 1 and 2 give some average figures on pollution of natural water.

Table 1 Average waste discharge in surface water bodies
By watersheds, million cubic metres per year

Indices	Total	Amur river	Lake Baikal	Lena river
Total amount of discharged waste water:	**365,31**	**371,00**	**2,65**	**0,97**
a) polluted	83.05	81.68	0.44	0.93
b) partially clean	263.46	244.80	0.00	0.00
b) treated to standard quality	18.80	16.97	1.79	0.04

Table 2 Average annual amount of pollutants discharged with wastewater into the surface water bodies

Oil products Thousand tons	Suspended matter Thousand tons		Sulphates Thousand tons	Chlorides Thousand tons	Total phosphorus; tons	Ammonium nitrogen; tons
0.02	1.73		6.02	3.64	31.6	443.21

Phenols; tons	Nitrates; tons	Synthetic surfactants; tons	Garbage oil; Oils; tons	Iron; tons	Copper; tons	Zinc; tons	Chromium; tons
0.42	1216.19	7.57	291.27	19.20	0.59	2.69	0.4

Cadmium; tons	Magnesium; tons	Manganese tons	Nitrites tons	Fluorine; tons
0.014	4.48	0.98	31.96	32.79

The borders between Transbaikalia Krai and China and Mongolia are rather extensive. Thus, a part of ecological problems is of trans-boundary character.

Trans-boundary water bodies on the territory of Transbaikalia Krai and Mongolia include Onon river with tributaries Ashinga, Baldzha, Kyra (the Amur river basin) and Menza river (the basin of Lake Baikal). The Onon and the Menza heads are located on the territory of Mongolia; the Ashinga, the Baldzha, the Kirkun and the Kyra heads are located on the territory of Transbaikalia Krai and fall into Onon river in Mongolia.

The 930km long Russia-China border runs through the water way of Argun river. The major part of the Argun watershed area is located on the territory of China. Great amount of pollutants in concentration exceeding the maximum permissible one enter the Argun from China. According to the data provided by the Transbaikalia centre of hydrometeorology and monitoring of the environment, the maximum concentrations of most pollutants were registered in winter and exceeded maximum permissible concentration of the following materials: organic substances in terms of chemical oxygen demand – by five times, organic substances in terms of biological oxygen demand in five days – by six times, phosphates - by two times, Cu ions - by 29 times, nitrite nitrogen – by 11 times.

During the open channel period the following maximum concentrations exceeding the permissible level were registered: phenols – by 7 times (Molokanka village), oil products – by 8 times (Molokanka village), Zn ions – by 7 times (Molokanka village); total iron – by 11 times (Kaylastuy village).

Generally the Argun river waters are characterized as dirty and very dirty (water quality degree 4, categories «a», «b» and «c», specific combinatorial water contamination rate - 3.72 - 5.63). The typical pollutants are: organic substances (in terms of chemical oxygen demand and biological oxygen demand in five days), oil products, total iron, copper, zinc, phenols, and nitrite nitrogen. Critical values of water pollution are dissolved oxygen, copper, zinc, and nitrite nitrogen. Argun river is registered in the “List of water bodies requiring top-priority water-protective measures", made by Rosgidromet with respect to the territory of Russia.

The Upper Amur region has a great economic value in Transbaikalia Krai. It is the most populated and developed part of Transbaikalia. The population density on this territory is 4.4 men/km^2 (the average density in Transbaikalia is 2.7 men/km^2) altering from 11.9 in the Ingoda river basin to 2.2 men/km^2 in the Shilka river basin. Thus, the major amount of water consumers is concentrated here - about 90% of all the consumers in the region.

Generally the basin of the Upper Amur head can be referred to the areas poorly supplied with water resources. Such condition stimulates the deficit of water supply resources and violation of hydroecological safety in terms of hydroeconomy. Only some parts of the Upper Amur basin may be classified as moderately supplied with natural water; in Russia these areas are the basins of the Argun, Shilka and Ingoda rivers.

There are two major aspects arising along with water use in terms of hydroecological safety of economic development of the territory: volumizing of permissible water intake from a water body in order to meet sanitary and ecological flow standards, and ensuring compliance with quality standards of water bodies, specified with account of the purpose the body is utilized for. In recent years, due to a number of low-water years, a hydroeconomic crisis has been brewing at the trans-boundary water bodies of the region with a potential to grow into an ecological crisis. The project designed in China envisages partial diversion of runoff of the Argun upstream (on the territory of China – Hailaer) to Lake Dalainor. According to various data the projected volume of diversion may exceed 1km (up to 2km) of water per year (under the average long-term river flow of the Argun river in the area of Russia-China border crossing -3.14km, in low-water years – 1.5km). According to the expert opinion, if irrecoverable flow losses exceed 25% of the average long-term flow the river basins would suffer from ecological crisis [2]. According to the current RF Water Code, clause 6 of Article 60 (Federal Law No. 74 dated of 03/06/2006) it is prohibited to take (withdraw) water resources from water bodies in volumes negatively affecting the state of such water bodies. Implementation of large investment programs for the development of some mineral deposits, construction of plants (cement and pulp), objects of power economy, transport etc. in Transbaikalia Krai would increase fresh water intake in the region by approximately 100 million cubic meters per year, and waste water disposal by 40 million cubic meters per year.

Thus, determination of water supply potential of trans-boundary areas is necessary. According to Russian standards possible resources for water use for water flows in natural (unregulated) state are established in the average amount of 30% of the "stable" runoff rate (minimum flow in the limiting period) [3]. According to the stipulated standards, the average water supply potential of the area within the territory of trans-boundary basin of Upper Amur river amounts to the average of 1.489 cubic kilometres per year, including: 1.056 cubic kilometres per year which are formed on the territory of Transbaikalia Krai (0.832 cubic kilometres per year – in the Shilka river basin and 0.224 cubic kilometres per year - in the Argun river basin), and 0.433 cubic kilometres per year which are formed on the territory of China (0.331 cubic kilometres per year – the Argun river basin) and Mongolia (0.102 cubic kilometres per year – the Shilka river basin). Thus, the potential (actual) volume of irrecoverable water intake amounts to approximately 5% of the average river flow of this basin. According to the international standards the permissible limit of water intake from trans-boundary objects should not exceed 12% [4]. These indices should be considered for determination of quotas for irrevocable water consumption from the trans-boundary water systems. In 2005-2006 the water intake from trans-boundary bodies of the Upper Amur region located in Transbaikalia amounted to 21.8%, the volume of irrevocable consumption amounted to 6.4% of the Russian water supply potential. The specified indices are expected to increase in the future to 31% and 12% respectively, i.e. water consumption in Transbaikalia Krai in the nearest 10-15 years will not exceed water supply resources.

Crises can also be caused by pollution of rivers. According to the Water pollution index a large part of the region's water bodies is classified as moderately polluted (Ingoda and Chita rivers upstream from the city of Chita, Onon, Kyra, Ilya, Aga, Borzya, Unda, Turga, Shilka, Nercha, Uldurga, Chernaya, Amazar, Mogocha, Urulyunguy rivers) through to polluted (the Ingoda downstream from the city of Chita, the Uldza) and dirty (the Chita downstream from the city of Chita, the Argun) [5] In recent years the trans-boundary water of Argun river, which flows to Russia from China, has been characterized as very polluted and dirty according to the Water Pollution Index. According to the expert estimate of the Far Eastern Research Institute of Integrated Use and Protection of Water Resources (DalNIIVH) (Vladivostok) the share of China in the Argun basin amounts to 87.5% of waste discharge in the surface water bodies [6]. From the Russian side the Argun has water intake facilities which supply water to inhabited localities; the quality of water sources for such facilities does not meet the norms established for such purposes [7].

Exceedence of hydroecological safety parameters may damage water bodies and deplete river flow. It is necessary to develop an International programme for hydrogeological provision of social and economic development of the Upper Amur region, which would include the development of limits for irrevocable water intake and waste discharge to trans-boundary water bodies, installation of water treatment systems at public water supply facilities located at trans-boundary water sources, preparation for operation of reserve water supply sources based on ground water deposits. In order to prevent crises related to water supply deficit, it is also necessary that these regions ensure economic use of water reserves and increase (extend reproduction) of sustainable discharge and, subsequently, increase water supply potential.

The most important problem for aquatic ecosystems is **invasion** – the spread of alien species.

Invaders introduce themselves in the material and energy flow of ecosystems and, as a rule, modify their structure and functioning. This process, which is called "biological contamination", changes the quality of water. The effect of biological contamination, unlike other types of human impact, is irreversible. There are diffuse areas of the spread of alien species in Transbaikalia Krai, they are mainly caused by introduction efforts. These efforts include the introduction of herbivorous fish into Kharanor reservoir, introduction of peled *Coregonus peled (Gmelin)* and omul *Coregonus autumnalis migratorius (Georgi)* into Krasnokamensk reservoir, lake Balsino, and some other water bodies of the Onon-Torei closed depression [8].

All in all, 16 invasive species have been recently registered in the regional water bodies. Four species are the native ones, eight species were introduced from other regions. The fewest number of alien species of fish is characteristic of the Lena basin (1), the largest for the Amur (8) and the Baikal (7) basins.

Amphipoda *Gmelinoides fasciatus* possesses a broad ecological plasticity. This species migrates when its biomass reaches several kilograms per one square meter of the bottom. Owing to high quantitative indices and production rates it promptly becomes a part of the ecosystem process of material and energy transformation. This species can negatively impact the diversity of communities by eating or forcing our native species [9]. In Lake Arakhley the native species of amphipoda *Gammarus lacustris* coexist with *G. Fasciatus* [10].

***Perccottus glenii Dybowski* – Amur sleeper**

Its natural habitat includes Korea, North of China, Primorye, lower and middle reaches of the Amur, the Sungari, the Ussuri and lake Khanka. Introduction and efforts of aquarians expanded the sleeper's habitat, at the moment one can distinguish Petersburg, Moscow, Kazakhstan-Central Asian and Baikal focuses of expansion. In 1996 we registered Amur sleeper in the upper Amur basin for the first time, in the mouth of river Srednyay Borzya. The emergence of the sleeper in Krasnokamensk reservoir in 2003-2004 caused the change of fish community from Rudd - Crucian carp – European carp to Sleeper-Crucian carp – European carp. The sleeper was also registered in the tributaries of Argun river (the Budymkan, the Urymkan). In 2006 the sleeper appeared in Unda river [12]. The sleeper can enter in competitive relations with valuable and target species; it can eat out spawn, larval fish and young fishes of valuable species (Coregonus chadary, great Siberian sturgeon, European carp). The emergence of sleeper in Krasnokamensk reservoir caused the emergence or earlier unregistered parasites [13].

Three lips - ***Opsariichthys uncirostris (Temminck et Schlegel)-*** its natural habitat includes middle and lower reaches of the Amur, the Sungari river, rivers of the Khanka lake basin, Southern China, rivers of Japan. In 1996 it was registered in the upper Amur basin for the first time in the heat sink of Kharanor HEPS. At the moment this species can be seen in the Onon river basin through to Nizhniy Zasuchey and Stary Durulguy. These are the main habitats of great Siberian sturgeon *Huso dauricus (Georgi)* and Coregonus chadary *Coregonus chadary Dybowski.* Being a typical predator three lips can eat spawn and young fishes of the indicated species. It shows good rate of growth in new conditions [14].

River perch ***Perka fluviatilis Linnaeus*** – is a wide spread Eurasian species. The introduction of perch in Lake Kenon in 1919 caused fast elimination of Amur fish fauna forms, and now perch is the dominating species in the lake. In 1968 perch was introduced in the Upper Darasun ponds from where it spread around the Shilka basin. In 2005 this species was registered in the estuary part of Aga and Onon rivers. Being a predator and euryphagous animal perch enters into competitive relations with other predators [15].

In 2009 in Lake Kenon - in the heat sink of Chita Thermal Power Plant -1 an invasive species – Canadian waterweed (***Elodea Canadensis*),** the highest aquatic plant, was registered for the first time. Canadian waterweed is an invader from North America. Since the beginning of the XIX century this plant has invaded many ecosystems of North Eurasia. The introduction of Canadian waterweed to the Eastern Siberia started in the 60-ies of the XX century from Irkutsk reservoir to Angarsk reservoir, littoral zone of Lake Baikal, and the Selena river basin. The year of 2001 saw its expansion to the lakes of the Eravno-Kharginsk system [16]. This plant is often called “water pest” or “water plague” because of its fast expansion and growth in very thick bushes. It is known that mass expansion of Canadian waterweed can force out local plants and animals, cause the death of aquatic organisms and fish, it can also cause death of swimming birds in the vegetation during food finding. It is known that Canadian waterweed caused an ecological catastrophe in Lake Kotokel located near the Baikal.

Thus, the expansion of invaders creates new and very serious environmental problems.

Reference

1. Official report “On the state and protection of environment in Chita oblast in 2004-2005”. - Chita: Committee of industry and natural resources of Chita oblast, 2006. – 110 pages.
2. N.I.Alekseevsky, N.G.Frolova. Hydroecological security of the territory: cases of change and ways to enhance reliability// Fundamental problems of water and water resources at the turn of the third millennium: Proceedings of International conference – Tomsk: Publishing house NTL, 2000, pages 4-7.
3. I.L.Savelyeva, L.A.Bezrukov, L.B.Bashalkhanova and others. Natural-resources potential of Irkutsk oblast. Irkutsk: Publishing house Siberian branch of the Russian Academy of Science, 1998. - 238 pages.
4. Revsky A. Water factor: the selfishness of Chita threatens Kazakhstan with the ecological catastrophe. - http://www.apn.kz/publications/article5569.htm, 2006-08-31.
5. Official report “On the state and protection of environment in Chita oblast in 2000”. - Chita: Committee of industry and natural resources of Chita oblast, 2001, 141 pages.
6. Protection of trans-boundary water reached expertise//Russia/ Nature and environment, 30.10.2007. - http://zabinfo.ru/print.php?sid=39781&pwd.
7. Y.V.Zima, G.I.Nikiforova The state of Argun river water quality// Natural resources and problems of geosphere research: Proceedings of International conference – Chita: Publishing house of Zabaikalsky state humanitarian pedagogical university, 2006, pages 179-181.
8. Gorlacheva E.P. The change of biological diversity of fish in Chita oblast under the influence of introduction//International scientific conference "Natural and invasive process of formation of biological diversity of aquatic and terrestrial ecosystems, Rostov on Don, 2007 – pages 90-92.
9. V.E.Panov Baikal endemic amphipoda Gmelinoides fasciatus Stebb in Ladoga lake// Report of the Russian Academy of Science, volume 336 #2, pages 279-282.
10. D.V.Matafonov, M.Z.Itigilova, R.M.Kamaltynov. Peculiarities of expansion of Gmelinoides fasciatus (Stebbing, 1899) in water bodies of Eastern Zabaykalye (case study Lake Arakhley)//Siberian ecological journal. 2006. Volume 13 (5) pages 595 - 601
11. Pronin N.M., Bolonev E.M. On modern area of invasive sleeper Perccottus glenii (Perciformes: Odontobutidae) in Baikal region and its penetration in the ecosystem of open Baikal//Ikhthyology issues.2006.Volume 46.#4.pages 567-568
12. M.Ts.Itigilova, E.P.Gorlacheva, A.V.Afonin, A.P.Kuklin, B.B.Bazarova, E.B.Matyugina, E.Yu.Afonina, P.V.Matafonov, H.V.Saltanova Biological diversity of water ecosystems of the trans-boundary Argun river. // Proceedings of international conference “Condition, protection, reclamation and sustainable use of

biological resources of the inland water bodies”, Volgograd, 2007. Volgograd department of the Federal state scientific body the State research and development institute of lake and river fish farming. - Pages 125-127.

13. E.P.Gorlachev Perccottus glenii Dybowski feeding in the Upper Amur basin // Freshwater ecosystems of the Amur river basin. - Vladivostok: Dalnauka, 2008.- pages 287-293.
14. E.P.Gorlachev, A.V.Afonin. Alien fish species of the Upper Amur basin // Proceedings of international conference “Ichthyologic studies of the inland water bodies”, Saransk, Mordoviya state university, 2007. - Pages 31-33.
15. E.P.Gorlacheva, A.V.Afonin. Perca fluviatilis- alien species of the Upper Amur basin //Conference “Marine ecology 2007”, Vladivostok,2007. - Pages 181-185
16. B.B.Bazarova, N.M.Pronin. Expansion and environmental niche taken by Elodea canadensis or “water plague” in the aquatic ecosystems of northern Eurasia //Utilization and protection of natural resources in Russia. 2006. № 4 (88). Pages 88-92

The peculiarities of macro- and microelemental composition of drinking water in the North Kazakhstan oblast' as an environmental factor affecting human health

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A,stract. The increased content (as against MPC and natural concentrations in R.Ishim) of main macroions (CO32-, HCO-, Cl-, SO42-, Ca2+, Mg2+), iron, manganese and (in some cases) zinc, lead, aluminium and nitrites in potable water of the North Kazakhstan Oblast' is caused by secondary pollution of canalization water. It was found that cancer cases are registered more often in the regions using common water main (CWM) for the last ten years than in the ones where water is not supplied by CWM.

Introduction

Environmental and population morbidity monitoring is an important tool for studying and assessment of risk factors in human health. Drinking water is one of the crucial geochemical ecological factors affecting the population health [1-3].

The supply of population with high quality water is one of the most topical problems for Kazakhstan. The North Kazakhstan Oblast' (NKO) is situated in the semiarid zone with specific geological-structural peculiarities that adversely affects the formation of surface and ground water resources.

Methods

To study health state of NKO population, the data from statistical reports "Public health in the North Kazakhstan Oblast'" for 1998-2005 as well as Information Bulletins on the Environment State in the North Kazakhstan Oblast' for 2005-2007 issued by the Department for Natural Resources and Nature Management served as the source material for investigation.

In the fall of 2008 and in the summer of 2009 field trips to NKO were made. Water samples (total 57) from centralized (water mains) and decentralized (underground wells) water supply sources were collected in 0.5 ml clean polyethylene bottles. Ionic composition of potable water was evaluated using the standard methods [4]. The content of microelements As, Cd, Fe, Mn, Mo, Zn, Pb, Se, Cr was estimated by means of atomic absorption spectrometry with electrothermal atomization.

Results and Discussion

To provide the NKO population with water, the surface water resources of R.Ishim are used. The aridity of the Ishim catchment area contributes to the increased content of dissolved salts in soils that enter the river from the watershed with melt water. According to the data on the Petropavlovsk region, in the summer of 2009 the sum of main ions in the R.Ishim water (mineralization) made up 830 mg/l, hardness index was 6,6 mg-eq/l, pH – 8,1-8,2. Ca^{2+} ranged within 52-60 mg/l that agrees with other published studies [5], while Mg^{2+} concentration was a bit higher , i.e. 43-48 mg/l. The content of mineral forms of N in R.Ishim is rather low.

It is known that the content of main macroions (Ca^{2+}, Mg^{2+}, Na^{+} HCO_3, Cl^{-}, SO_4^{2}) in drinking water determines its physiological full value [1-4]. Longstanding consumption of water with unbalanced (by main indices) composition may cause different human diseases and health deterioration.

The studies of potable water in NKO (Table 1) show that 37% of samples from water supply sources exceed MPC by total content of main ions, 48% - by hardness (38% - by Mg), 68% - by Iron, 19% - by Manganese.

Table 1 Concentration of elements and compounds in the water from various water pipelines and decentralized (underground) water supply sources in NKO (2008-2009.)

Index	MPC	Ishimsky water supply system	Bulaevsky water supply system	Underground sources
pH	6,5-8,5	7,0-8,2	7,1-8,2	7,2-8,1
Mineralization, mg/l	1000 (1500)	795- 2894	484 - 1946; 3385	444 - 2046
Hardness, mg-eq./l	7 (10)	5,4-24,6	3,2 – 18,6	2,6-27,5
Calcium, mg/l	180	8 -264	6-176	4 - 248
Magnesium, mg/l	65 *	38,4 216,0	21,6 – 153,6	9,6 – 325,2
Chlorides, mg/l	350	132-840	24 - 1217	45-539
Hydrocarbonates, mg/l	400 *	256 - 616	189-653	186,1 – 872,3
Sulphates, mg/l	500	117-570	83-560	4 -577
Nitrates, mg/l	45	0,19-19,34	<0,02-19,34	<0,02-243,67
Nitrites, mg/l	3,3	<0,007-3,14; 4,77	<0,007 – 1,54	<0,007-3,72; 7,08
Arsenic, μg/l	50	<0,5	<0,5– 5,3	<0,5-26,5
Cadmium, μg/l	1	<0,01-0,31	<0,01-0,31	<0,01-0,1
Copper, μg/l	1000	<1-39,2	<1 – 23,0	<1-20,6
Nickel, μg/l	100	<1 - 2	<1 – 5,3	<1- 8
Iron, μg/l	300 (1000)	40 - 5400	40-4800	11- 4000
Manganese, μg/l	100	2,6 - 780	<1 - 270	<1 - 370
Lead, μg/l	10	<0,5 – 5,53	<0,5-5,3	<0,5 – 3,8
Aluminium, μg/l	500	20 - 150	12 - 300	4 – **5000**
Zinc, μg/l	5000	1,4 - 6700	<1-74; 1800	<1; 990

Note: MPC for decentralized water supply sources is given in brackets
** -Quality standard for water of 1st class (according to SanPiN 2.1.4.1116)*

It should be noted that some NKO water samples are distinguished by specific Ca-Mg ratio, significantly shifted towards Mg. It is considered that the increased concentration of Mg amplifies gastrointestinal tract irritation caused by sulfates [6], but at the same time it makes a positive effect on cardiovascular system [7].

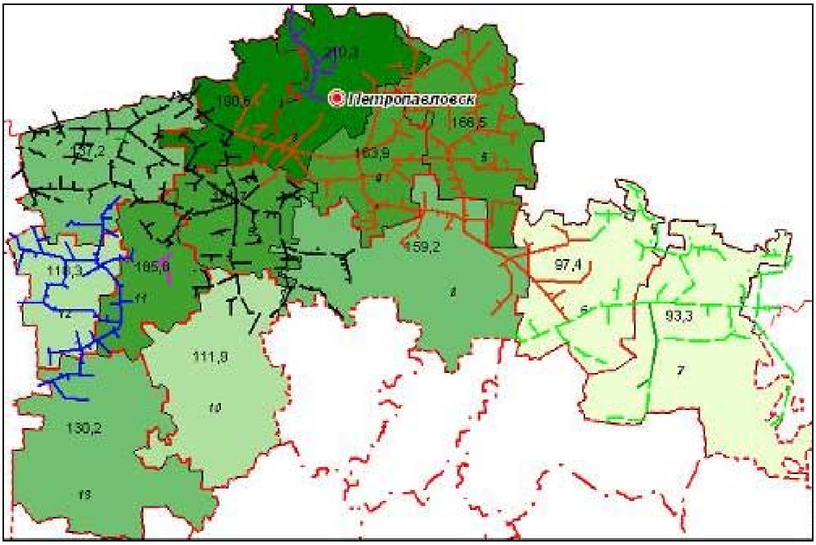
Nitrogen compounds are one of dominant forms of potable water pollution; they considerably determine the ecological and sanitary water state. [2, 4]. It appears that nitrate content in drinking water samples from NKO were within 0,19-27,6 mg/l, while nitrites – from 0,007 to 1,79 mg/l. The increased content as against MPC (45 mgNO_3/l and 3,3 mgNO_2/l) of nitrates (243,67 mg/l) and nitrites (4,77 mg/l at MPC=7,08 mg/l) is evidence of "fresh" anthropogenic water pollution found in the water of decentralized water supply sources.

Often, the increased content of main macroions is registered in the water of decentralized (underground) water supply sources, especially situated nearby the flood-plain landscapes. The largest number of samples with the increased and abnormal concentration of Mn and Fe was revealed in common water supply systems (in the summer of 2009, Fe excess made up 4 mg/l in 4 water samples taken from water mains), Zn (up to 6,7 mg/l, in Gorodetskoye village). Small villages where the increased concentration of Fe, Zn, NO_2 and Cu, Cd, Pb (as against natural concentrations) was noted are characterized by irregular water intake and often low advance speed of water in the system. It is common knowledge that stagnation increases corrosion [8, 9, 10], tube walls release more Fe and Pb [8, 11], NO_2 concentration in water supplied by new zinc-coated pipes at low water flow velocity may reach 89 MPC [12].

Other chemical elements of 1, 2 and 3 hazard classes referred to essential and conditionally essential microelements [3] , i.e. As, Pb, Cd, Cu, Cr, Mo, Se, Al generally don't exceed MPC (for household and drinking water) in drinking water of NKO, except for village Sivkovo, where aluminium concentration in water is abnormally high (5 mg/l at MPC=0,5 mg/l). Aluminium sulfate is widely used at water stations as a coagulant.

Thus, macro- and microelements concentrations in tap water of NKO is higher than in natural waters.

Water quality has an effect on malignant neoplasms morbidity [13]. The averaged indices of sickness rate of cancer by NKO administrative districts for 1999-2005 superimposed with the water mains scheme (CWM) allows us to assume the presence of direct relation between the increased cancer morbidity and the water consumption from water mains (Fig. 1). In the regions where water was not supplied by CWM, cancer cases are scarce as compared to the ones where water was supplied by CWM for the last ten years (Akzharsky, Ualikhanovsky, Airtaussky, G.Musrepov regions).



Regions: 1. Zhambyl'sky, 2. Mamlyutsky, 3. Kysylzharsky,4. Akkainsky, 5. M. Zhumabaev, 6 Akzharsky, 7. Ualikhanovsky, 8. Taiynshinsky, 9. Yesil'sky, 10 Airtaussky, 11. Shal Akyna, 12. Timiryazevsky, 13. G.Musrepov Мусрепова
288,9 – a standardized index of cancer morbidity

Fig. 2 Scheme of water mains and averaged sickness rate of malignant neoplasms by administrative districts for 1999-2005

Conclusion:

1. The presence of macroions, Fe as well as Mn, Zn, Al and NO_2 (in some samples) in drinking water is one of natural factors affecting NKO human health.
2. The increased content of Fe, Zn, Al, Mn, and Cd, Cu, Pb in some sites of water supply system is probably caused by secondary water pollution.
3. The correlation between cancer morbidity and groups of people who consume water from common water supply systems and wells is observed.

References.

1. Руководство по контролю качества питьевой воды. Т.2. Гигиенические критерии и другая релевантная информация. Женева: ВОЗ, 1987. 38 с.
2. Онищенко, Г.Г. Влияние состояния окружающей среды на здоровье населения. Нерешенные проблемы и задачи /Г.Г. Онищенко//Гигиена и санитария.– 2003.– №.1. –С.3- 9.
3. Авцын, А.П. Микроэлементозы человека: этиология, классификация, органопатология / А.П. Авцын, А.А. Жаворонков, М.А. Риш, Л.С. Строчкова. – М.: Медицина. 1991. - 496 с.
4. Новиков, Ю.В., Методы исследования качества водоемов / Ю.В. Новиков, К.О. Ласточкина, З.Н. Болдина. – М., 1990. – 397 с.

5. Алекин, О. А. Основы гидрохимии/ О.А. Алекин. – Л.: Гидрометеоиздат, 1970. – 413 с.
6. *СанПиН 2.1.4.1116-02* Питьевая вода. Гигиенические требования к качеству воды, расфасованной в емкости. Контроль качества. Действует с 01.07.2002. Утвержден 15.03.2002 главным государственным санитарным врачом РФ.
7. Кротков, Ф.Г. Смертность от сердечно-сосудистых заболеваний и жесткость воды / Ф.Г. Кротков //Гигиена и санитария.- 1973.-№4.-с.69-73
8. Butterfield, Ph.W., Minimizing biofilm in the presence of iron oxides and humic substances /Ph.W. Butterfield, A.K. Camper, J.A. Biederman, A. M.Bargmeyer // Water research – 2002. - Vol. 36. - №15. – P. 3893–3910.
9. Муринов, С.К. Влияние внутренней коррозии трубопровода «Астрахань-Мангистау» на качество воды. /С.К. Муринов, А.А. Бут, Е.Н. Байбатыров, Г.А. Ивлева, И.И. [и др.] // Питьевая вода. №2, 2002. с. 14-19.
10. Niu, Z. Iron stability in drinking water distribution systems in a city of China / Z. Niu, Y. Wang, X. Zhang, W. He, H. Han, P. Yin // J. Environmental Science. – 2006. - Vol. 18. - № 1. - P. 40-46.
11. Swiderska-Broc, M. Wplyw nierownomiernosci rozbioru wody wodociagowej na zmiane jej jakosci [Влияние неравномерности отбора воды из водопроводной сети на ее качество] /M. Swiderska-Broc, M. Wolska // Ochrona Srodowiska. - 2004. - № 4. – P. 21-23.
12. Hautmann, A. Gefahren durch Nitritbildung in neuinstallierteu Verzinkten Wasserleitungen /A. Hautmann // HLH: Heizung, Luftung/ Klima, Haustechn. - 1998. – Vol. 49. – № 10. - P. 34-36, 38, 81.
13. Маймулов, В.Г. Система мероприятий по предупреждению и уменьшению возникновения экологически зависимых заболеваний / В.Г. Маймулов, Б.В. Лимин, Т.В. Карлова и др.//Гигиена и санитария.– 2007.– № 6.– С. 14-17.

Determination of Lead and Arsenic in Drinking water of the selected Localities of Pakistan

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Abstract. Arsenic (As) and Lead (Pb) are among the most health hazards elements. Both metals are water soluble and can exist in various oxidation forms. In the present work total content of these metals have been quantified in drinking water of five Districts of Pakistan, namely Peshavar, Maran, Gujarat, Jaranwala and Faisalabad. The results show that Arsenic is present in greater quantity (10.5 to 60ppb) then pemissible limit (WHO 10ppb) in the drinking water of two districts that is Faisalabad and Jaranwala. Lead (Pb) concentration was found to be with in the normal range in these districts. The water of Mardan and Peshavar districts contain a slightly high concentration of As and Pb than the (WHO) permissible limit. The results from district Gujarat shows high concentrarion of both Pb (10.5 to 29ppb) and As (10.5 to 125ppb).

Keywords: Lead (Pb), Arsenic (As), Determination.

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Introduction:

Water is one of most essential thing for all living organism. Almost 70% of the earth crust is covered with water but fresh water consist only 3% of it, out of which about 1% is unusable and only 0.01% is available for domestic use. Pakistan is one of the most populated countries and its population is expected to be doubled in the next few years. The quality of drinking water is very poor in Pakistan. According to a UNICEF survey in 2003, 30-40% of all diseases are water born. Every year thousand of deaths occur due to drinking of contaminated water. Arsenic and lead are among the most hazardous toxic elements.

Arsenic is a naturally occurring inorganic element having no taste, smell, and color, found in soil and in surface water and ground water, highest in areas of geothermal activity. Arsenic is a redox sensitive element. Total arsenic is the sum of both particulate arsenic and soluble arsenic. Soluble arsenic occurs in two primary forms, inorganic and organic. Inorganic arsenic can occur in the environment in several forms and valencies.

In drinking-water, it is mostly found as trivalent arsenite (As^{+3}) or pentavalent arsenate (As^{+5}). Arsenic is unique among the heavy metalloids and oxyanion-forming elements in its mobilization at the pH values typically found in groundwater (pH 6.5–

8.5). The valency and species of inorganic arsenic are dependent on the redox conditions and the pH of the water. In general, arsenite, the reduced trivalent form (As^{+3}), is normally found in groundwater (assuming anaerobic conditions) and arsenate, the oxidized pentavalent form, (As^{+5}) is found in surface water (assuming aerobic conditions), although the rule does not always hold true for groundwater. Some ground waters have been found to have only As^{+3}, others only As^{+5}, while in some others both forms have been found in the same water source.[1] As^{+3} is generally more toxic to humans and four to ten times more soluble in water than As^{+5}.[(2)]

Arsenic is also used in the production of pesticides and herbicides and ingested by drinking contaminated water. It can enter in the metabolic system of new born babies.

Ingestion of large quantity results in stomach pain, nausea, vomiting, diarrhea which may lead to shock, coma and even death. At higher concentration it can produce cancer of lungs, bladder, kidney, liver and skin, particularly in adults. The new born babies and people with suppressed immunity are at greater risk of arsenic poisoning. [3, 7]

Lead (Pb) is a serious cumulative body poison. The possible chronic effect is o brain nerve system, kidney damage, digestive disorders, blood disorder and hypertension. The symptoms of acute poisoning are tiredness, lassitude, slight abdominal discomfort, irritability, anemia and behavioral changes.[4.] The natural Pb content of lake and river water worldwide has been estimated to be 1-10 µg/L .[5, 8-21]

Experimental work:

Instruments/Techniques used:

Atomic Absorption Spectrophometer, Vario-6 Analytik JENAAG.

1. Hydride Technique (HG_AAS) is used for the determination of Arsenic with a Lamp current of 8 Ampere, Slit width 0.8mm and pressure 3-5 bars was used for necessary temperature(950°)
2. Graphite Furnace Technique is used for Lead with a Lamp current of 8 ampere, Slit width of 0.5mm and Atomization Temperature- 1500-2000°C

Chemicals used:

Lead nitrate, Nitric acid, Sulfuric acid, Arsenic trioxide Sodium borohydride (NaBH4, 98% purity), Sodium hydroxide, NaOH, Hydrochloric Acid (Concentrated 37% HCl),.

Collection of water Sample: Water samples were collected from district Peshawar, Mardan, Faisalabad, Gujarat and Jaranwala of Pakistan according to standard method. The preservative (1% concentrated HCl) was used in the samples collected for arsenic analysis. For the determination of Lead samples were acidified by the addition of 2 ml of concentrated HNO_3 per liter of sample prior to storage in a plastic container.

Standard solution preparation:

- **Preparation of stock solution of Lead**
  1000 ppb stock solution was prepared by using lead nitrate according to standard method. Solutions of different concentration were prepared by using dilution formula.
- **Preparation of stock solution of Arsenic:**
  1000 ppb stock solution was prepared by using Arsenic trioxide (As_2O_3) according to standard method (Arsenic Standard (1007 mg/ml, As in 2% HNO_3,) for HG_AAS mode. Solutions of different concentration were prepared by using dilution formula.

Procedure:

For the determination of Arsenic in dinking water standard solutions in range from 0.2-200 ppb were prepared The Hydride technique makes the use of hydrogen liberated in the reaction of the weakly acidic sample solutions with sodium boro-hydride which combines with metal ions to form gaseous hydrides. These are carried to the hot quartz cell by the carrier gas and decomposed by collision processes in a series of steps to form free atoms. Calibration was evaluated by the value of R2 i.e. 0.99. (Degree of fitness, between concentration and absorbance). After calibration all the samples were analyzed using wavelength 193.7 nm in the hydride generation Mode. Argon gas was used as a carrier gas. The gas valve box supplied argon gas for scavenging and for transporting the metal hydrides to the system. The detection limit of this method is 0.1 ppb. For the accurate measurement of Arsenic in drinking water, a blank and standard was runed after every 10 samples. For the reproducibility, from every 10 samples one pre-analyzed sample was rechecked randomly. 10.02% samples were rechecked and results showed the %age of reproducibility less than 10%. (Internationally recognized value for the quality control).

Lead was determined by using Graphite mode of Atomic absorption at 217nm. The atomization temperature was kept between 1500-2000°C. Nitric acid solution (0.5%) was used as a blank. Standard working range from 0.2 – 200ppb was used. Argon gas was used as a carrier at pressure ranges from 3-5 bars. The temperature of atomization was kept 1800°C. Calibration was performed with a known concentration using the stock solution of 100 ppb.

Results and discussion:

Total 43 samples were collected from district Peshawar for the analysis of lead and Arsenic, out of which only 9.3% samples were contaminated with Arsenic (figure-1). Lead was found within permissible range (figure-2). Similarly from the district Mardan total 27 samples were collected, out of which 18.5 % were contaminated with Lead (figure-4). Arsenic was found with in the permissible limit (figure-3). From Faisalabad district total 63 samples were collected and more than 50% were found contaminated with arsenic. (Figure-5). Lead was found within permissible limit (Figure-6).

From the district Gujarat 58 samples were analyzed for Lead and Arsenic, out of which 34.5% were contaminated with Arsenic (figure-7). Lead was found within the permissible range (figure-8). From the Jaranwala district 58 samples were collected for analysis, out of which 52% were contaminated with Arsenic (figure- 9). Lead was found with in the permissible range (figure-10).

Conclusion:

The results show that Arsenic (As) is present in greater quantity in the drinking water of District Faisalabad, Gujarat and Jaranwala as compared to permissible limit (10ppb). Arsenic was found in the range from 10.5 to 125 ppb. Lead (Pb) concentration was found in normal range in these districts except in District Mardan. The presence of grater quantity of arsenic in the drinking water of the selected localities is a serious treat for human life. As these areas are located in the high temperature zone. People are seriously exposed to the Arsenic treat due to uptake of large quantity of water especially during summer. The water of Mardan and Peshawar contain a slightly high concentration of As and Pb than the permissible limit (WHO). It could be concluded that the drinking water of District Mardan and Peshawar are comparatively safe for drinking purpose in term of heavy metals like lead and arsenic and the drinking water of Faisalabad Gujarat and Jaranwala are unsafe for drinking purpose due to presence of greater concentration of Arsenic.

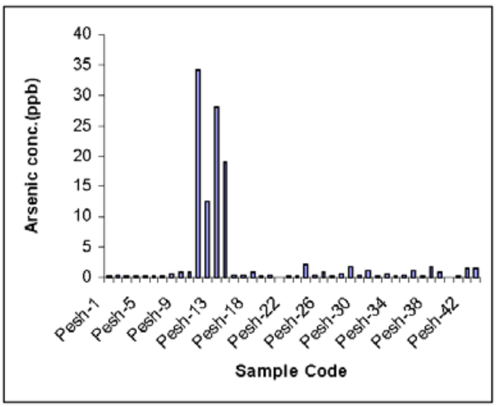

Figure 1 Concentration of Arsenic in the drinking water of district Peshawar

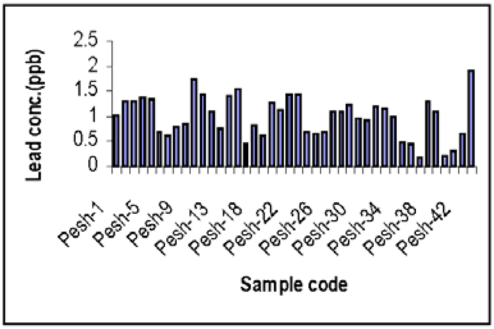

Figure 2 Concentration of lead in the drinking water of district Peshawar

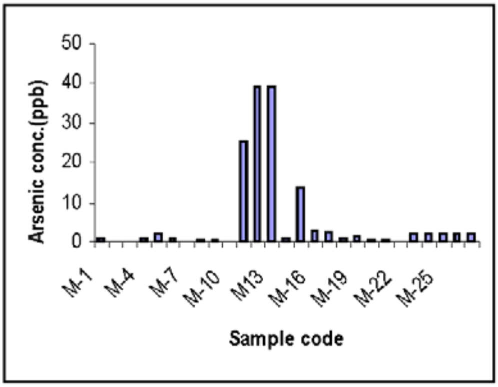

Figure-3 Concentration of Arsenic in the drinking water of district Mardan

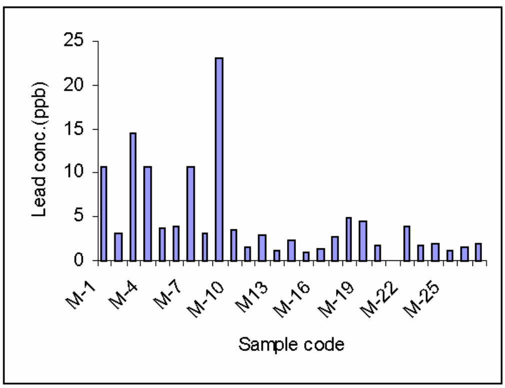

Figure 4 Concentration of Lead in the drinking water of district Mardan

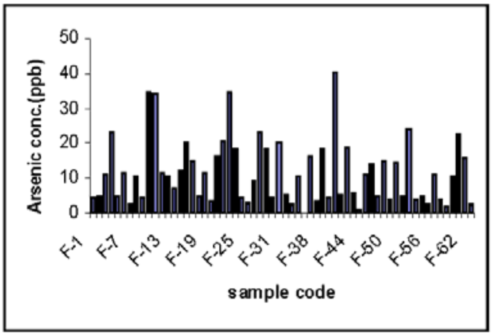

Figure 5 Concentration of Arsenic in the drinking water of district Faisalabad

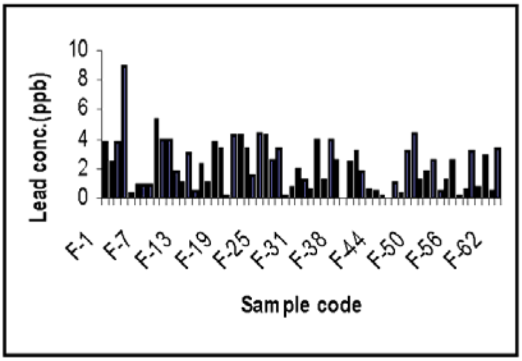

Figure 6 Concentration of lead in the drinking water of district Faisalabad

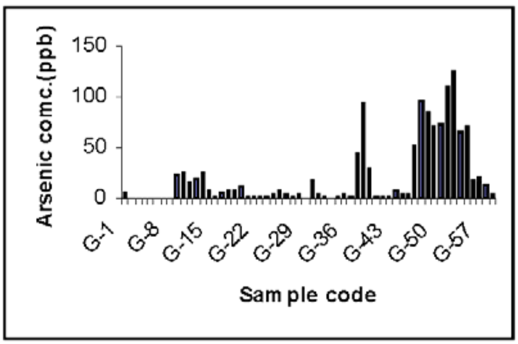

Figure 7 Concentration of Arsenic in the drinking water of district Gujarat

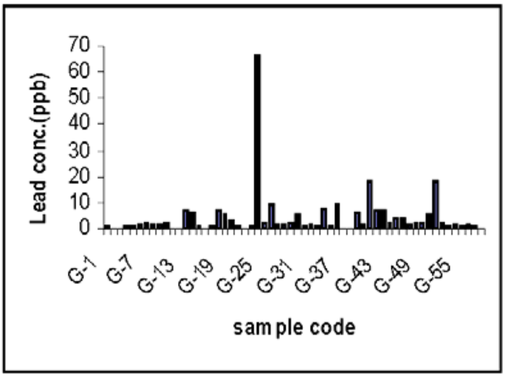

Figure 8 Concentration of Lead in the drinking water of district Gujarat

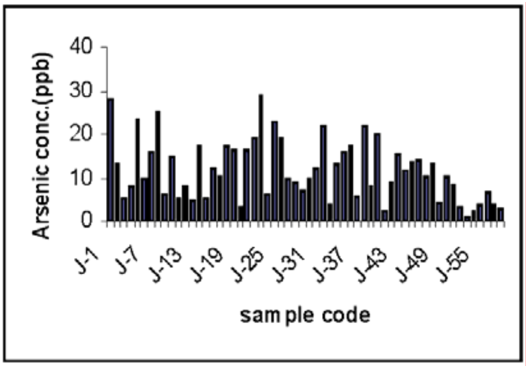

Figure 9 Concentration of Arsenic in the drinking water of district Jaranwala

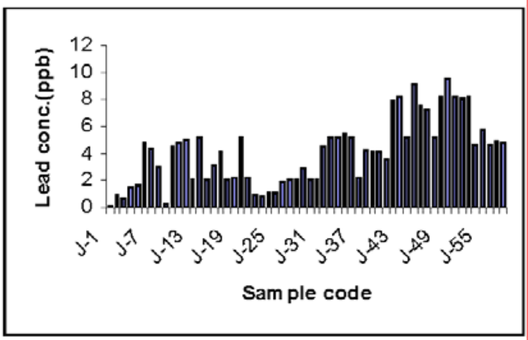

Figure 10 Concentration of Lead in the drinking water of district Jaranwala

References:

1. 'Arsenic in drinking water'. Thematic Overview Paper 17 By: Branislav Petrusevski, Saroj Sharma, Jan C. Schippers (UNESCO-IHE), and Kathleen Shordt (IRC)
2. (USEPA. 1997; USOSHA, 2001).

3. USDI, 2001.
4. SWFF 2003, “Drinking water quality and health”. Safe drinking water foundation.http://www.safewater.org/members/teachers/water and health.com
5. WHO report, 1973, “The hazards to health and ecological effects of persistent substances in environment”. World health organization Copenhagen.
6. Ferguson and Gavis 1972; Korte and Fernando 1991; Cheng et al. 1994; Hering and Chiu (2000).
7. Wardatul Akmam, Sk. Muaj Hurayra Marshad, Md. Fakrul Islam, ”Arsenic Contamination in Ground Water in Bangladesh: Nature of Awareness in an Arsenic prone Area” . Eubios Journal of Asian and International Bioethics (EJAIB),page 162, vol 17,issue 1173-2571, 2007.
8. Brodkin E, Copes R, Mattman A, et al.”Lead and mercury exposures: interpretation and action”. CMAJ; 176:59-63, 2007
9. US Environmental Protection Agency. Air quality criteria for lead (final). Volume I. Research Triangle Park (NC): National Center for Environmental Assessment; 2006. Report no EPA/600/R-5/144aF.
10. Lanphear BP, Hornung R, Khoury J, et al. “Low-level environmental lead exposure and children's intellectual function: an international pooled analysis”. J.Environ Health Perspect;113:894-9,2005
11. Braun JM, Kahn RS, Froehlich T, et al. “Exposures to environmental toxicants and attention deficit hyperactivity disorder in US children”. J.Environ Health Perspect; 114:1904-9,2006
12. Sanborn MD, Abelsohn A, Campbell M, et al. “Identifying and managing adverse environmental health effects”. CMAJ; 166:1287-92, 2002
13. National Research Council, Committee on the Institutional Means for Assessment of Risks to Public Health. “Risk assessment in the federal government: managing the process”. Washington (DC): National Academy Press; 1983.
14. World Health Organization, “Healthy Environments for Children Alliance. Lead” [Issue Briefs series]. Geneva: www.who.int/heca/infomaterials/lead.pdf.
15. Qizhong Guo., “Increases of lead and chromium in drinking water from using cement—mortar-lined pipes: initial modeling and assessment”, Journal of hazardous material, volume 56, issue 1-2, 1997.
16. Nriagu, Jerome O. (1983). “Lead and Lead Poisoning in Antiquity”. New York: John Wiley & Sons. pp. 437.
17. “Effects of lead on human health. In: It's Your Health”. Ottawa (ON): Health Canada; 2004.www.hc-sc.gc.ca/iyh-vsv/environ/lead-plomb_e.html
18. Gochfeld, Michael, "Chronologic history of occupational medicine". Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine 47 (2): 96–114. 2005.
19. Debendra N Guha Mazumder, Reina Haque, Nilima Ghosh, Binay K De, Amal Santra, Dipankar Chakraborti and Allan H Smith, “ Arsenic in drinking water and the prevalence of respiratory effects in West Bengal, India”. International Journal of Epidemiology; 29:1047-1052, 2000.
20. Twarakavi, N. K. C., Kaluarachchi, J. J. "Arsenic in the shallow ground waters of conterminous United States: assessment, health risks, and costs for MCL compliance". Journal of American Water Resources Association 42 (2): 275–294, 2006.
21. Mukherjee A., Sengupta M. K., Hossain M. A. "Arsenic contamination in groundwater: A global perspective with emphasis on the Asian scenario". Journal of Health Population and Nutrition 24 (2): 142–163. (2006).

About one of real ways of potable water conditioning and economy of its resources

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All of us are aware of great importance of potable water in human life. This is our main vital product without which the existence is impossible. In connection with this, there are special requirements to water quality. First of all, potable water should be safe in sanitary, epidemiological and radiating aspects, have favorable color, taste and smell, to be harmless as to its chemical composition and mineralization.

However, potable water should be not only pure and harmless, but also useful for man, i.e. to have optimum microelement, mineral, gas, and other composition. This is associated with the fact that water, which we drink, determines the activity of all important organs of a human body, its salt and gas exchange, properties and regeneration of blood, the condition of skin, muscular and bone tissue, character of oxidation processes of food, its digesting, and etc. In this significant qualitative influence of potable water on vital activity of human body the leading role belongs not only to its general chemical composition, but also to microcomponental, microbiological and other ones. It was proved that the absence in potable water of such microelements as copper, cobalt, manganese and molybdenum negatively affects blood formation and functioning of enzyme systems. The absence of iodine in water lowers thyroid gland activity. Low content of fluorine worsens the general state of health. Such microcomponent as bromine regulates activity of the higher nervous system. As a whole, the microcomponents containing in water increase the intensity of bioenergetic processes and improve protective reactions of an organism preventing the development of various infectious and hereditary diseases thus promoting the prolongation of human life [6].

Unfortunately, the second important part of quality of potable water, its utility, is not given due attention. In the majority of settlements superficial sources are used for portable water supply, the water of those is not only poor in useful microelements (fluorine, iodine, bromine, manganese, and etc.), but also becomes rather dirty resulting from human-induced impact. In the Republic of Sakha (Yakutia), for example, the centralized water supply is available only for 30 % of inhabitants. However, even in this case potable water quality is very low because of nonobservance of sanitary protection zones on the operating water intakes, insufficient sanitary reliability of the applied systems of water conditioning, the deterioration of water supply systems and their accident rate [5]. In rural settlements portable water is supplied directly from the rivers and lakes without special water preparation and disinfecting. More than 60 % of the reservoirs used for portable water supply do not meet the requirements of hygienic specifications as to sanitary-chemical and microbiological indicators. High degree of microbal pollution of water is a principal cause of high sickness rate of the population by intestinal infections. Thousand cases of the diseases connected with water factor are annually registered in the Republic.

Similar situation is basically observed throughout Russia. For today, every second inhabitant of the country has to use portable water not meeting sanitary-and-hygienic requirements for a number of indicators. More than 22 % of the population have no centralized water supply and consume water without necessary preliminary preparation. The centralized water supply systems are absent in 12 % of cities and 68 % of rural settlements [3]. Nevertheless, even in the settlements with centralized systems of water supply, the quality of water is extremely unsatisfactory.

The applied system of water disinfection by chlorine is not only outdated, but also dangerous for human health. Chlorination causes the formation of toxic halogen-containing compounds in water. Trying to clean tap water from compounds of chlorine, iron and to give to it the corresponding organoleptic properties, people have to apply different household filters. However, such "water preparation" leads to removal of useful components from potable water, that is to getting of actually distilled water. The use of such water is not less dangerous as causes washing out of salts and mineral substances from an organism. To prevent various intestinal diseases, sanitary-and-epidemiologic and medical services recommend tap water drinking only after its necessary boiling. However it is known that regular use of soft boiled water results in cardiac muscle defeat, narrowing of vessels of a brain, decrease in weight of bones and many other adverse consequences for a human body.

The water conditioning problem should be solved together with a problem of preservation of quality of the cleaned water in the course of its transportation to the consumers by external and domestic water supply systems. The deterioration of communications, the use of mainly steel pipelines which cause secondary pollution of water nullify the effect of existing water preparation. Resulting from corrosion of pipelines and the associated physical and chemical and microbiological processes the water arrives to the consumers with high level of toxicity.

One of the ways of the decision of the problem of population supply with potable high-quality and good for human body water is the use of fresh ground water, and, first of all, artesian water. Circulating in rocks during hundreds and thousand years, this water is enriched by a multitude of microelements and mineral substances. Besides, it differs from superficial water by exclusive sterility and less susceptibility to various types of human-induced pollution and climate changes.

However, fresh ground water has limited reserves in comparison with huge resources of superficial water. An intensive use of underground water-bearing horizons forms deep depression funnels, which not only complicate and raise the price of water used, but also leads to decrease of the ground water quality. This is associated with the fact that in the zones of influence of deep depressions of level the vertical filtration of ground water intensifies thus causing the penetration of various polluting substances from the surface to productive water-bearing horizons, as well as raising of nonstandard water from lower water-bearing complexes [1,2,7,8]. Hence, fresh ground water having significant advantage comparing to superficial water sources should be used in reasonable limits and protected from exhaustion and pollution.

For rational use of fresh ground water the application of duplex system of water supply is reasonable, its essence being the following. It is known, that with centralized water supply the average requirement of one man for water was defined from calculation to be about 200 liters a day. From this amount only 8-10 liters of water, that is less than 5 %, are used for satisfaction of physiological requirements of a man (drinking, cooking). The main amount of water supplied to the population by services of municipal water supply is used for domestic daily living needs (a bath, a shower, premise cleaning, linen washing, etc.). The use for these purposes of the most valuable fresh ground water, also after certain water preparation, is certainly irrational and prodigal. The duplex system provides division of water delivered to the population, separately for drinking and domestic daily living needs. The importance of its application has been already marked in publications [4].

Basic advantages of introduction of such system are the following:

1) reduction of diseases and increase of lifetime of people due to the use of good for health potable water;

2) considerable reduction of expenses for preparation of high-quality portable water in connection with water supply division according to use purposes;

3) preservation of water quality during its transportation from stations of water conditioning to consumers using modern antiwear materials in water supply systems;

4) protection of population in cases of extreme situations and acts of terrorism;

5) rational use of resources of fresh ground water and prevention of their exhaustion;

6) conformity with resource-saving strategy of development of the country.

The staff of Melnikov Permafrost Institute, SB RAS within the framework of the Republican program «Pure Water» in the Republic of Sakha (Yakutia) offered the experimental working out of such system for one of microdistricts of Yakutsk. The main objective of this experiment is studying of possibility and efficiency of application of duplex system of high-quality and useful for health potable water supply under climatic, permafrost-hydro-geological and social and economic conditions of the Republic. For this purpose, the use of fresh subpermafrost water of the Yakut artesian well after the appropriate water preparation is provided (fig. 1). The system of potable water supply to consumers will be arranged as an addition to already existing water supply systems. This will reduce the expenses for construction of similar system, and the use of modern antiwear materials will considerably increase the term of its operation.

The offered operational site of the water-intake well is located in Central-Yakut reservoir of the ground subpermafrost water with confirmed reserves of category C_1 in the amount of 7878 m3/day. Water from the well is fresh chloride-hydrocarbonate sodic with mineralization of 0.9 g/l and a complex of components useful for human body. In water, the excess of maximum permissible concentration of sodium content - 277 mg/l (maximum concentration limit is 200 mg/l), fluorine 3.7 mg/l (maximum concentration limit is 1.5 mg/l) and lithium 0.18 mg/l (maximum concentration limit is 0.03 mg/l) is observed. In the course of water preparation the content of these elements will be lowered to normalized requirements.

Sanitation at the water-intake well is quite favorable because the well is located in the area of continuous permafrost more than 300 m thick reliably protecting subpermafrost water from superficial pollution.

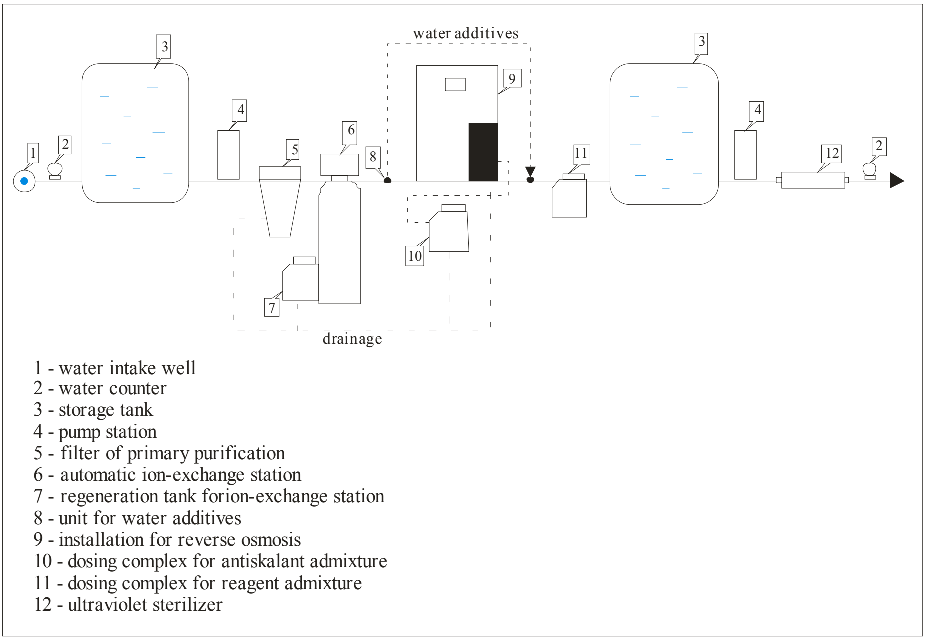

Fig. 1 The basic technological scheme of water preparation

The experiment involves providing about 1400 people of microdistrict «Merzlotka» in the city of Yakutsk with qualitative ground subpermafrost potable water. Preliminary calculated capital expenses necessary for realization of this experiment will amount 8 684 598 roubles. Based on preliminary calculations of production costs, 1 liter of potable water will cost 1.32 rbl., the planned price of realization - 2 rbl. per 1 litre. The calculations permit us to assume that the general efficiency of the project will be 51 %. The development of the project shows, that the organization and operation of the duplex system of water supply is not only socially proved, but also economically reasonable, since the total sum of capital expenses will be repaid within five years.

When a pilot-industrial experiment is successfully carried out the recommendations on application of duplex system of water supply will be developed to provide the population with high-quality potable water. Further introduction of this system in the country will allow:

- to satisfy the requirements of the population for clean potable water in necessary amount, of required quality and at a reasonable price;
- rational use of fresh ground water resources, prevention of its exhaustion, that, as a whole, corresponds to resource-saving strategy of the development of the country;
- to improve technical and sanitary reliability of water pipelines;
- to reduce the expenses for high-quality potable water preparation;
- to provide the safety of potable water in cases of extreme situations and acts of terrorism;
- to improve sanitary-and-hygienic indices of potable water thus lowering the risk of diseases of the population associated with water factor;

- to improve potable water quality in the objects of social infrastructure, including schools, kindergartens and hospitals;

- to eliminate deficiency of water supply in rural settlements;

- to improve knowledge of the population about the importance of quality of consumed water, to involve people in the process of efficiency of the use of high-quality potable water and its resource-saving.

In our opinion, only qualitatively new water sector, resource-saving, economically effective, dynamically developing, quickly reacting to innovative ideas and use of new technologies can meet the requirements of new time. The offered duplex system of water supply is just what we need. Realization of this idea will allow us to improve the functioning of water sector and to guarantee the population of the country clean, and the main thing, good for health potable water for reasonable price. It is supposed, that general social and economic effect of the use of duplex system of water supply will be achieved due to decrease of diseases, increase of lifetime of the population and improvement of social and ecological conditions in the country.

References

1 Alekseev S.V., Boldovskoy N.V., Bukaty M. B, et al. Present condition of hydrogeology of Siberia and the Far East, the XXI century problem in the direction of research//Materials of the All-Russia meeting on ground water of the East of Siberia. - Irkutsk: IrGTU Publishing House, 2003. - pp. 3-12.

2 Voronov A.N. Hydrogeology is a science about underground hydrosphere (a diamond of pure water in a necklace of geological sciences)// Future of hydrogeology: recent trends and prospects. – St.Petersburg: St.Petersburg State University, 2007. - pp. 3-8.

3 Grigoriev E.G. Water Resources of Russia: problems and methods of State regulation. –M.:2007.-240 p.

4 Krivorotov N.M. Pure water is not a pink dream//Urgent problems of providing the population of the Republic of Sakha (Yakutia) with good-quality potable water. - Yakutsk, 2000. - pp. 19-22.

5 Prokopyeva M.V. About hygienic problems of economic-drinking water supply in the Republic of Sakha (Yakutia)// Science and technology in Yakutia, 2003, №1. - pp. 35-38.

6 Shepelev V.V. Spring water of Yakutia.-Yakutsk: Yakut Publishing House, 1987.127 p.

7 Shepelev V.V., Skutin V. I. Conditions and prospects of the use of ground water in the Republic of Sakha (Yakutia)//Science and education, 1997, №1. - 92-99.

8 Sheshenya N.L. Problems of water supply in the cities of Siberia and the Far East//Underground hydrosphere: Materials of the All-Russia meeting on the ground water of Siberia and the Far East. - Irkutsk: IrGTU Publishing House, 2006. - p. 305-308.

Climate & ecosystems change and its adaptation programs in Korea

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Abstract. Climate and ecosystems change is the most pressing threat to the world's environment, already contributing to visible impacts on human health, food security, economic activity, water and other natural resources, and physical infrastructure. It is very likely that most of this climate change in the current era is the result of human activities which have increased concentration of green house gases in the atmosphere and led the earth to warm. In this sense, decisive success for the climate change adaptation in the long run is dependent upon deepening knowledge, awareness raising and conviction of individuals and communities on the pivotal role of environment plays in human livelihoods. Therein lies the important role of higher education for deepening our knowledge of climate change impacts and assisting in the adaptation process.

There is growing evidence that Korea is vulnerable to the impacts of climate change. In the span of the last century average temperature has risen at more than twice the global average and annual rainfall and days with heavy rainfall have increased in the southern region of Korea. The change resulted in the more frequent storms and flooding events and the disruption of the ecosystem as seen in the early flower blossoms and changed in fish species. Moreover, frequent drought events are highly due to massive fluctuations in runoff each season by climate change. Therefore, comprehensive governmental countermeasure plans have been established and enforced four times in response to climate change since 1999, and research activities and higher educational programs for climate and ecosystems change adaptation in various sectors have been developed and being carried out. Apart from regular university degree programs on climate and ecosystems change, various special graduate school programs and short period education programs have been developed and under operation at the present.

Introduction

The whole world is being affected by climate change which therefore needs to be addressed by concerted global efforts. Nearly every powerful interest in the world has now accepted the reality of climate change and the impact of cumulative human activities on the climate. Politicians, sociologists, economists, business people, and military think tanks are focusing more and more on what many are calling the likelihood of climate disruption, which is as just scary as it sounds. Climate change is a truly global challenge. Addressing climate change requires involvement and action at the local, regional and global level, and education has a central role to play in understanding, mitigating and adapting to climate change. Mitigation is the principal way of reducing greenhouse gas (GHG) emissions and is essential to the response to global warming, especially in the long-term. It is essential to adapt to the current and future impacts of climate change. Regardless of whatever mitigation measures that will be taken, the decisions we make today will have long lasting consequences.

The Fourth Report of the Intergovernmental Panel on Climate Change (IPCC) has brought to the fore the severity and global dimension of the impacts of climate change. In Asia, climate change at the current rate is expected to put close to 50 million extra people at risk of hunger by 2020, rising to an additional 130 million in 2050. Glaciers in the Himalayas could, at similar rate, disappear altogether by 2035. Further, the IPCC report notes that Europe's vast reaches of low lying coast are vulnerable to sea level rise likely to threaten up to 2.5 million people. In the Korean Peninsula, the climate change could be even more noticeable. Analysis has emerged indicating the Korean Peninsula is warming at more than twice the speed of the global average. During the last century, the winter season has shortened by more than a month, and the summer season has grown by almost two weeks. It is therefore important that the urgent need for assistance to vulnerable countries to adapt, as well as in investment for climate proofing of economies now and in the future. This is as much about investment in careful and considered planning including higher education incorporating a better understanding and application of indigenous knowledge and traditional coping strategies. Decisive success in the long run is dependent upon deepening knowledge, awareness raising and conviction of individuals and communities on the pivotal role environment plays in human livelihoods. Therein lies the important role of higher education. Higher education can play a major role in meeting the targets that the international community has set for itself regarding climate change which encompasses setting the international community towards a prosperous economy; raising awareness of all greenhouse gas issues among communities to drive action to reduce emissions by individuals; and deepening our knowledge of climate change impacts and, where appropriate, assist in the adaptation process. Higher education institutions become a crucial role in finding the means to address climate change issues and to train future leaders to tackle it with a holistic approach. Universities play crucial roles in building the ability to adapt to a changing climate, in particular, in choosing appropriate and practical adaptation educations that reduce the vulnerability of our settlements and infrastructure, natural ecosystems and water resources to the impacts of climate change.

In this paper, vulnerability and impacts in various sectors due to climate and ecosystems change in Korea are introduced and their adaptation measures together with research and higher educational programs are given in response to climate and ecosystems change challenges.

Role of human beings

It is very likely that most of climate change in the current era is the result of human activities which have increased concentrations of greenhouse gases in the atmosphere and these gases trap heat and cause the earth to warm. This climate change in the current era is expected to be extremely rapid compared to transitions in and out of past ice ages and ecosystems are more vulnerable to changes that happen rapidly.

Human activities have many other effects on ecosystems, which compound the effects of climate change, making it more difficult for ecosystems to adapt by pollution, habitat fragmentation, invasive species, overfishing, manipulation of water sources … and much more.

However, changes in activities at the personal, community, and national levels can affect the rate of future climate change and species' ability to adapt. Some of areas where changes in human activities could help species adapt include:

- Approaches to agriculture
- Water management practices
- Energy sources and use
- Transportation
- Pollution remediation
- Biological conservation
- … and much more

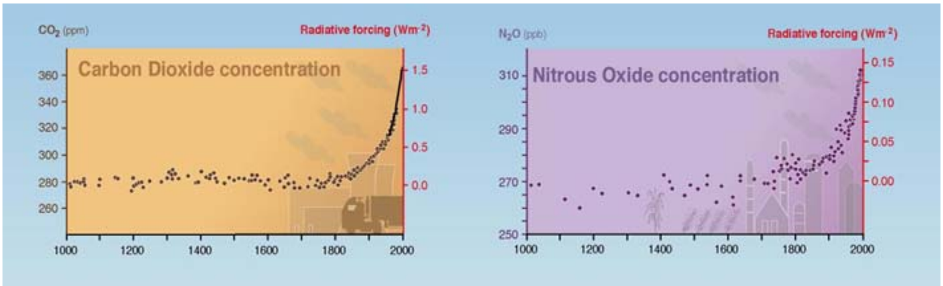

Fig.1 Indicators of the human influence

Vulnerability and impacts of climate & ecosystems change

There is growing evidence that Korea is vulnerable to the impacts of climate change. In the span of the last century average temperature has risen by 1.5°C (global average has risen by 0.6°C). Temperature has risen from 12°C in the 20th century to 13.5°C in the 21st century even when excluding the effects of urbanization, there was an increase of 0.4 -0.8°C. During the past 20 years, annual rainfall and days with heavy rainfall have increased in the southern region of Korea. Increase of annual rainfall by 7% and days with heavy rainfall by 23% and decrease of annual number of rainy days by 14% have been experienced. Occurrence of extreme natural disasters such as the heaviest snowfall in 32years, the worst drought in history, and the heaviest rainfall in 37years, are rising in frequency and intensity. It is estimated that the average climate will rise 1.2° by the 2020's, 2.4°C by the 2050's, and 4.0°C by the 2080's.

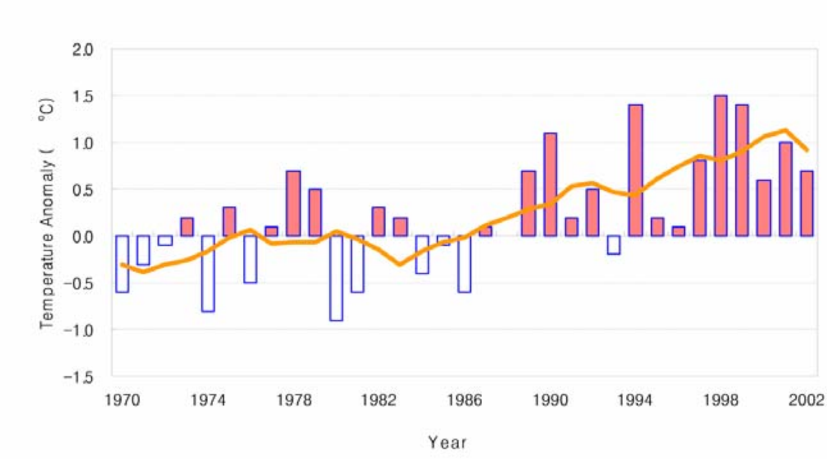

Fig.2 Temperature variation (Korea, 1970-2002)
Vulnerabilities and impacts on each sector have shown their severities and global dimension.

Agriculture:

Regions ideal for cultivation will proceed northward and expand due to global warming. Cultivation areas for warm season fruits including tangerine, citron, and kiwi fruit will expand whereas cultivation areas for temperate fruit trees such as apples, pears, peaches, grapes, etc are expected to face difficulties if global warming continues. Possibility of cultivating subtropical fruit trees in Jeju Island is expected, but regions growing cool-season vegetables will have to move north. Due to a rise in average temperature, frost damage has decreased and the damage from noxious insects has increased. A rise in frequency and intensity of damage due to agricultural atmosphere disaster will be met. The frequency of typhoon, hurricane, heavy snow, drought, hail, yellow sand storms, etc has increased from 48 cases in 1910 to 190 cases in 1990.

Forestry:

Change of air composition, such as the increase in density of CO2, and the extension of rearing period is anticipated to increase the productivity of mountains and forests. On the contrary, limiting factors such as forest fires, landslides, outbreaks of insects, pests and plant pathogens may occur. The number of subtropical insects and pathogens, as well as forestry viruses such as the pitch canker are expected to increase due to the rise in winter temperatures, allowing their transfer. Trees more acclimatized to colder environments such as pine trees may decline in number due to rise in winter temperature

Fisheries:

There lies a possibility that the rise in water temperature will change the surrounding temperate waters of Korean Peninsula to subtropical waters. During the past 30-40years, the catch of warm water fishery species such as mackerel, anchovy, cuttlefish, etc has increased. The winter fisheries for cuttlefish has moved 60miles north and expanded during the past 20years. The catch of cold water fisheries species such as walleye pollack, codfish, etc had decreased sharply. The rise in water temperature due to climate change may induce long-term and large scale red- tide, causing serious harm to the reproduction of fish and shellfish. The rise in sea level will cause a serious loss of vast tidal flats. Since many fisheries resources such as micro algae, zooplankton etc inhabit in tidal flats, encompassing the vital ecosystem, the loss of the area will bring about serious future damage.

Water resources:

Increase in the threat of floods will bring a great disaster and damages. Intensity of heavy rainfall in the summer will increase the damage due to floods and increase in the fluctuation of runoff will not add to the relief of water shortage. Droughts in Korea are also severe due to massive fluctuations in runoff each season.

Health:

Additional casualties due to intense heat will increase. In Korea, additional casualties due to intense heat were recorded in 1994. In the northern regions of Gyeonggi province, there was a consistent reoccurrence of malaria since 1993.

As a result of climate change, water related disaster paradigm is changing by frequent extreme events change, and species and ecosystems are experiencing changes in ranges, cycling of water and nutrients, timing of biological activity, growth rates, the risk of disturbance from fire, insects and invasive species, and relative abundance of species.

Adaptation measures and programs

Adaptation Counter Measures

Governmental Countermeasure Committee for the agreement on climate change has been launched (chairman: Prime Minister), in addition, a comprehensive plan was established and enforced four times in response to climate change. Till present, much emphasis was placed on the mitigation of Greenhouse Gas(GHG) emissions, and the evaluation on the impact of climate change and its adaptation measures are at their initial stages. Promotion for the basis of adaptation on climate change, national target rate of the mitigation of GHG emissions, warning system of climate change and disaster management system establishment were included from the 3rd('05~'07) and the 4th ('07~'12) Governmental Comprehensive Plan on countermeasures to climate change.

Adaptation countermeasures on each sector have been adopted according to their characteristics of vulnerabilities and impacts.

Agriculture:

It was suggested to foster species suitable to the changing climate, and to change the farming methods and the kind of crops being cultivated.

Forestry:

Forest hazard programs should be implemented to avert forest fires and landslides and policies for the maintenance in the productivity of forests should be prepared. Planting of tree species adequate for colder climates should be avoided while substituting other adequate species. Alien pest insects and newly introduced plant pathogens (especially those from the subtropical regions) should be closely monitored through strict inspection. Implementation of the ecosystem preservation framework is established and the preservation measures in regard to the species vulnerable to climate change should be strengthened.

Fisheries:

The impact and response to the rise in sea level of the peninsular are examined and establishment of defense measures on coastal erosion and structures is planned. Response to the diversification of fishery resources is also considered and continual monitoring of fishery resources through the prediction of the shift in fishery resources and change in fishing waters due to climate change is implemented.

Water Resources:

Integrated countermeasures for floods among ministries and government agencies have been adopted and the efficiency of water resources management has been increased. A systematic and accurate structure that will predict early warnings of floods to the central government and local authorities in order to minimize the damage from disasters has been adopted.

Health:

The formation of a fundamental management program and database for infectious diseases is planned and data from forecasts on the prevalence of malaria, Japanese encephalitis, cholera, vibrio, etc are accumulated.

Research Activities in Various Sectors

Active research activities for climate change adaptation have been carrying out in various sectors in Korea such as water resources, climate and environment sciences.

An improvement of design criteria for abnormal flood has been conducted under consideration of climate change to upgrade design criteria of hydraulic structure for safety as shown in Fig.3. Water resources assessment system for major basin using long-term climate forecasts has also been established with sustainable water resources research program and water security research program under climate change, etc.

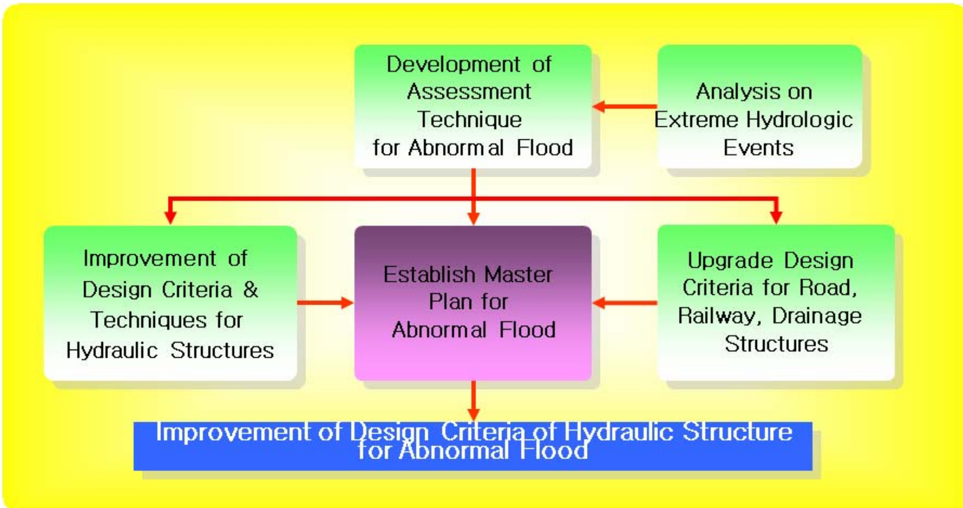

Fig.3 Improvement of design criteria for abnormal flood

In the fields of climate and environment, various research programs have been conducting in nationwide research organizations in consideration of climate change through the Korea climate impacts and adaptation action programme.

Educational Programs on Climate Change

Some universities and research institutes are offering educational programs on climate change in the field of atmospheric & environmental sciences, geoscience, hydrology and water resources and civil & environmental engineering according to the following climate change processes

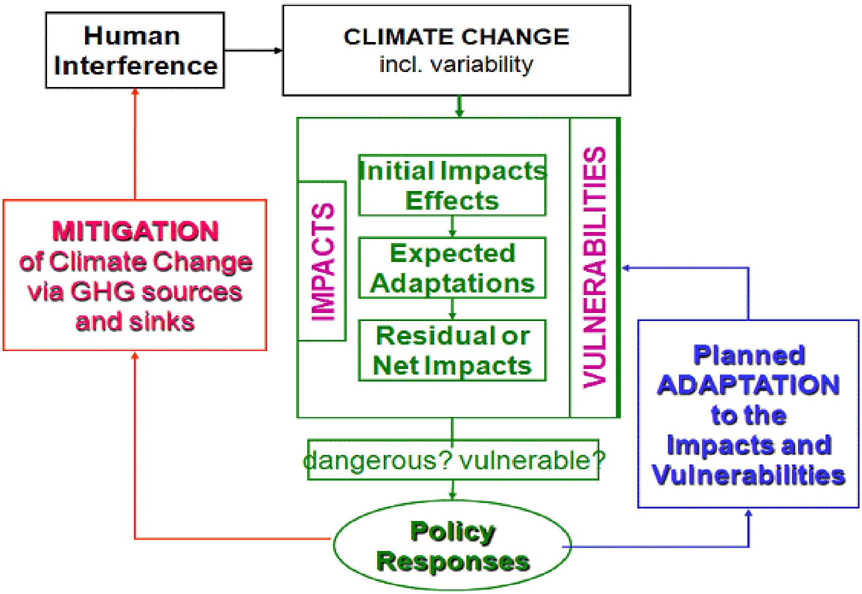

Fig. 4 Climate change processes

Adaptation subjects in education programs on climate change are as the followings:

- Climate change mitigation … Reducing GHG emissions, climate protection, global and long-term
- Climate change adaptation … Reducing negative impacts, or enhancing positive impacts of climate change, local, short- to long-term, emergency management and disaster mitigation
- Risk management … Identify, analyze, evaluate, identify options, implement and monitor mitigation strategies
- Risks change as the climate changes … Infrastructure has been based on assumption of a static climate
- Comprehensive adaptation plans require multiple stakeholders … Infrastructure, social issues, environmental issues, buildings, land-use planning, water resources, emergency management, etc.

Apart from regular university degree programs on climate change, the following special educational programs on climate change have been developed and are under operation at the present.

- Special Graduate School Program on Climate Change

This program has been developed by Ministry of Environment(MOE) for the education and capacity building and strengthening of research base in climate change in 2006 and financially supports university graduate students and the following research fields for five years initially;

- Greengas Emission Mitigation Measures and Policy
- Climate Change Impact Assessment and Adaptation Measures

  - Impact Assessment and Monitoring
  - Greengas Emission Statistics
  - Business Management Strategies of Climate Industries
  - Carbon Market and International Trading
- KMAA Education Program on Climate Change

Meteorological Science Academy of KMA operates special education and training course on climate change twice in a year for general people(NGO, business people etc.) and local government officials. Education subjects are all aspects of climate change and adaptation such as climate change impacts, adaptation measures, greengas emission mitigation & energy measures, national policies on green growth and carbon tax etc.

Among those educational programs, universities will play crucial roles in building the ability to adapt to a changing climate, in particular, in choosing appropriate and practical adaptation educations that reduce the vulnerability of our settlements and infrastructure, natural ecosystems and water resources to the impacts of climate change. Universities have begun to take the issue of climate change more seriously. In response to climate change challenges, it is necessary to launch a new program for climate change adaptation aimed at assisting countries and communities to increase their adaptive capacity from the impacts of climate change. Thus, three major steps in addressing the current void in higher education and action are suggested: 1) integrating climate change issues into basic and higher education curriculum, 2) promoting innovative approaches of learning in formal and nonformal institutions, 3) highlighting and enhancing diffusion of appropriate technologies for adaptation and mitigation of climate change.

Conclusion

Great vulnerability and impacts due to climate and ecosystem change are found and reflected not only in Korea but also in all global environment. It is also very likely that role of human beings causes most of the climate change by which change of water related disaster paradigm and ecosystems are experiencing its changes and variation.

In Korea, government comprehensive plan on countermeasures to climate changes was established and adaptation measures are being implemented according to this plan. Various research projects and activities on climate and ecosystem change are also being carried out and new higher educational programs including special graduate school program and other several education programs on climate change are developed and executed.

Major three steps in addressing the current void in higher education and action for climate and ecosystems change are suggested:

1) integrating climate change issues into basic and higher education curriculum
2) promoting innovative approaches of learning in formal and nonformal institutions
3) highlighting and enhancing diffusion of appropriate technologies for adaptation and mitigation of climate change

References

ALCAMO, J., M. Florke and M. Marker, 2007. Future Long-Term Changes in Global Water Resources Driven by Socio-Economic and Climatic Change. Hydrol.Sci.J.,52, 247-275pp.

IPCC(Intergovernmental Panel on Climate Change), 2007d. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the IPCC, Core Writing Team, R. K. Pachauri and A Reisinger, Eds. IPCC, Geneva, 102pp.

IPCC(Intergovernmental Panel on Climate Change), 2008. Climate Change and Water, Technical Paper VI. Contribution of Working Groups II, Bates, B. et al. Eds. IPCC, Geneva, 210pp.

OH, JAIHO, 2008. Global Warming and Its Impacts on the Intensity of Future Tropical Storm, Proceedings, Int'l Symposium on Hydrol. Environment, IHES(Int'l Hydrol. Environmental Soc.), Daegu, Republic of Korea, 41-47pp.

LEE, SOONTAK, 2009. Climate Change Adaptation and Its Related Higher Education Programs in Korea, Proceedings, Int'l Conference on Role of Higher Education in Adapting to climate Change, UN Univ., Tokyo, Japan.

Main achievements and perspectives of the AASA Clean Water Program

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Abstract: The issues of the international research cooperation among scientists and experts working in the Asian region in the area of hydrology are considered. The results were obtained within AASA Clean water program seven-year activities. Possible research areas for international cooperation in the nearest future are discussed. It is marked the additional capacities for sustainable water use in Central Asia exist in collaboration between the regional AASA Clean water program and the global IAP Water program.

Key words: AASA Clean Water program, IAP Water program, water use, water security, international research cooperation

Introduction

The beginning of the XXI century coincided with the development of the global water crisis. The irrevocable water use and the surface and ground water pollution increase with the growth of population and industrial production. Nowadays the critical situation with water supply takes place even in the regions rich in water resources, and it becomes the limiting factor for social and economic development of these regions. Therefore the problems of efficient water use and conservation come to the forefront among the common issues of nature management and environment protection. Many problems have the regional specific character and can be solved successfully only within the framework of international scientific cooperation. To overcome such challenges international hydrological investigations are of fundamental significance.

AASA program "clean water – a step forward"

The international program "Clean water" was adopted in Israel in 2002 to combine efforts of scientists from Asian countries-members of the Association of Academies of Sciences in Asia (Clean …, 2004) for making a complex assessment and conservation of surface and underground waters in Asian region. Today's problems of Asian water studies and protection call for integration and involvement of all stakeholders.

Last seven years the mechanisms for program realization were discussed and improved by countries-members of the Association of Academies of Sciences in Asia (AASA) in the course of implementation of projects dealing with solving water problems in Asia region at the national and international level.

At the beginning of "Clean Water – a Step Forward" program realization we hoped that the Clean Water program will be a good supplement to the existing international water programs worked out and implemented within the framework of UNESCO, UNEP, WMO, WHO and etc. To achieve program goals and objectives, to perform complex assessment of water resources as well as to study the aquatic ecosystems and chemical composition of the surface and underground water of Asia the following structure (major trends) of the "Clean Water – a Step Forward" program was proposed (AASA, 2004):

1. Assessment of water resources state in Asia;
2. Working out of the concept on water resources management in the Asian Region;
3. Water and human health;
4. Study of water structure and characteristics
5. Development of up-to-date technologies for treatment of drinking and sewage water;
6. Influence of transboundary transfer on environmental state of water objects;
7. Extreme hydrological situations caused by natural factors;
8. Inclusion of special protected natural water objects of Asia into the list of World Natural Heritage and their joint study.

During the seven-year investigations within framework of the Clean Water program various issues concerning the state of water resources and water management were considered and discussed the scientists and experts from different countries. Among them are the global water crisis, the problems and perspectives, the regional experience in water-related problems resolution in Central Asia, the management problems of transboundary water resources, the ecological and economic aspects of water management.

Examples of the present-day hydrological investigations on the Clean Water program

For the last 5 years within the framework of bilateral and tripartite joint projects the many scientific and practical works in line with the trends mentioned above or related ones were performed. Below we present some examples of the joint hydrological projects.

Hydrological investigations. The dependence of Altai low-mountain river runoff on meteorological characteristics was studied using the simulation model (where internal function of the catchment and meteorological characteristics, i.e. monthly precipitation and average monthly air temperature were input parameters).

It was found that winter precipitation amount has a major influence on Inya river runoff (low-mountain basin, altitudes don't exceed 500-600 m) that can be changed from – 42 to +85% if the ratio of annual winter precipitation amount to average one changes from 0,5 to 2,0.

The runoff remains practically the same in case if during a warm period the thermal regime (hence evaporation under condition of invariable winter precipitation amount and precipitation in warm period) changes. Moisture evaporation and loss set off the effect of each other.

Extreme hydrological situations caused by natural factors. The development of life support systems in all world countries including the ones in the Asian Region is followed by the increase of demands to the life safety conditions and reliability of natural and industrial systems. Among all the disasters, floods figure prominently in the damage caused. Therefore, it is necessary to extend the study of floods including the forecast methods. Besides, because of the growth of urban population and the development of urban infrastructure the problem of low water-level caused by droughts is critical. The lack of scientific knowledge in this field is apparent, though the problem is of crucial importance as for the continuous water supply of cities, industry and agriculture as for the maintenance of sound environment on the rivers. To discuss these issues the International Conference "Extreme Hydrological Events: New Concepts for Security" (NATO Advanced Research Workshop) was held in 2005 in Russia. After that the appropriate recommendations were prepared.

The modeling of hydrological and hydrophysical processes in the Aral Sea. In cooperation with the hydrologists from the Inter-Republican Research-Coordinating Center of Central Asia countries and the hydrobiologists from the Academy of Sciences of Uzbekistan the potential for ecosystem conservation and rehabilitation in the deepest part of the Aral Sea was studied. The modeling of hydrological and hydrophysical processes in water bodies in terms of water mineralization was carried out using the hydrothermodynamical model developed.

Possible hydrophysical changes in the deep-water part of the Aral Sea that might be expected under further sea degradation due to the scarce freshwater inflow were estimated.

It was shown that under sufficient freshwater inflow from Amu-Darya river water desalination in the sea site under study can be carried out (washing out the excess salt by the transference of the portion of entering water to the eastern part).

The preliminary calculation shows that in 10-15 years (since freshwater delivery begins) water salinity in the deep part of the sea under study can be reduced up to the environmentally sound level.

Ground water investigations. The unique innovation techniques may be used for remote sensing of underground water stock. In the end of 2007, under financial support of the Bortnik Foundation, the SB RAS specialists developed the mobile NMR-geoimager "Hydroscope". It was designed for the research conducted by IWEP SB RAS, i.e. the aquifer quest and measurement of such characteristics as the occurrence depth and the body of moving water. The instrument makes it possible to estimate the underground water stock and the contouring of deposits, and is the important supplement to traditional hydrogeological methods. The maximal quest depth is up to 120 meters, and the aquifer occurrence depth is 200 meters.

Previously, similar geoimager was approved in Siberia, Mongolia, Spain and China. Within the framework of the joint research the studies on the aquifer quest and measurement of the occurrence depth, the body of moving water, the content of diamagnetic, paramagnetic and carbon admixtures were carried out. At present, the possibility to do similar research within the framework of Water Program is under discussion.

Remote geoecological monitoring of water objects, salt soils and wetlands. This line of research includes the following techniques for remote monitoring of water resources:

A). Method for remote estimation of salt mass concentration in water:

- It is based on the use of salt mass concentration dependence of water surface emittance in microwave range;
- It rests on the use of the model of complex permittivity of water-salt solution;
- It takes account of the change in solutions' dielectric properties due to the formation of hydro shell around the ions of the salt dissolved.

B). Method for remote microwave estimation of soil moisture:

- It is built upon the dielectric properties of dry soil, free and bound water.
- Relative error in estimation of W in the range between 0.10 and 0.30 makes up 10-12%.
- It was tested in the south of West Siberia (Altai Krai and Kemerovo Region).

C). Method of remote microwave sensing of underground water occurrence depth:

- It is based on the steady dependence of emittance on the underground water occurrence depth observed at 1-3 m beneath the surface.
- Relative accuracy in the underground water occurrence depth sensing within 1…3 m is within 20%.
- It got approval in Altai Krai and Kemerovo Region during the inspection of the following engineering constructions:
  - Kulundinsky channel (Altai Krai);
  - Industrial collectors of the Altai ore mining and processing enterprise;
  - Belovo reservoir (Kemerovo Region).

D). Aerospace mapping of soil moisture and underground water occurrence depth on regional scale

- It is based on the use of the orbital infrared survey, aircraft microwave survey, model presentation of moisture distribution in capillary edge;
- It allows us to obtain the information on overwetted soil distribution throughout large areas.

Working out of the concept on water resources management in the Asian region. Joint research on issues of transboundary cooperation in the field of biological and landscape conservation as well as social-ecological development of Altai Mountain Region were carried out by experts from Russia, Mongolia, Kazakhstan and China. A specific program's block is devoted to assessment of Altai Mountain Region role in water resources formation in Central Asia. As a result national reports were prepared; transboundary feasibility study of "Altai"TBT was performed; the map of water resources threats in the Altai-Sayan ecoregion (1:500000; in traditional and electronic forms) was constructed.

NATO Advanced Research Workshop "Transboundary water resources: strategies for regional security and ecological stability" was held on August 25-27, 2003 in Novosibirsk Scientific Center (Russia) where various aspects of transboundary water resources state and their management, namely global water crisis, problems and prospects, regional experience on water problems solution in Central Asia; issues and management of transboundary water resources, ecological and economical aspects of water resources management were discussed.

International cooperation within the framework of AASA Clean Water Program and IAP Water Program

Currently, to make the AASA Clean Water program implementation more effective the outcomes of the work on the Program for the last seven years are discussed and the future activity trends are specified (Vinokurov, 2005). It's reasonable to solve the global water crisis problems within the framework of the Program making the emphasis on the following issues:

- water security and sustainable water use;
- human health and water;
- surface water and groundwater monitoring;
- hydrological cycle and water extremes.

In future much attention should be given to organizational issues including the coordination of joint research. The topic of coordination of investigations on "Clean Water" Program with the ones carried out on the IAP Water Program needs to be discussed.

The challenges of global water crisis require essential joint scientific, technological and managerial actions in to use the more advanced results and technologies to recover degraded surface and groundwater reserves and to secure the necessary water resources.

To decide these problems IAP established the IAP Water Program. This program is presently structured worldwide, based on 65 national focal points globally distributed as follows: Africa (6 Academies); Americas (14 Academies); Central Asia (6 Academies); East Asia & Pacific Region (9 Academies); Middle East & South Asia (10 Academies; and Europe (20 Academies). Additionally, Tanzania, Zambia and Nicaragua, which are countries with no Science Academy, participate in the program as observers.

During the last three years the IAP Water program regional workshops were held and these workshops helped to identify general and regional demands. The goal of the workshops was to organize exchange information and experience among scientists and specialists on the present state-of-the–art for different areas of water researches, promote international research cooperation and regional networks. The SB RAS researchers and experts were involved into IAP Water program activities and represented its interests in Central Asia. These specialists also work within AASA Clean water program activities. In many Academies of Sciences in the Asia-Pacific Region, the Central Asia Region and the Middle East Region the situation on the whole is the same. Therefore one of the nearest initiatives of the AASA Clean Water program may be the holding of the joint meeting with IAP Water program to collaborate efforts of scientists and specialists from these Academies of Sciences in more effective overcoming the water problems on global and regional scales.

References

Clean Water – a Step Forward. AASA Joint Programs // AASA Newsletter. 2004, Vol. 1, No. 2, P. 2-5.

Vinokurov Yuri I. Development of Mu Shik Jhon's concepts in current research within 'Clean Water – a Step Forward' program // Proc. Inter. Symposium of the AASA on Science and Technology of Water (October 12, 2005, Seoul, Korea), KAST, 2005, P. 39-43.

Peculiarities of water use in basin of Irtysh River

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Abstract. Irtysh River is the largest tributary of the Ob; its catchment basin occupies the territory of three countries, namely, China, Kazakhstan and Russia and is characterized by the extremely critical water economic conditions.

The dynamics of water use in the Irtysh basin is such that along with the reduction in water use (fresh water, reverse and successive water supply) the increase of effluents discharge is observed.

Considering the transboundary character of the Irtysh basin, the stabilization of water economic situation here calls for the development of the coordinated plan of actions of all countries and regions within the basin. It should be aimed at the achievement of sustainable development of these territories in socio-economic, ecological and legal fields.

WATER MANAGEMENT ISSUES OF CONSTRUCTION OF LARGE RESERVOIRS IN SIBERIA AND POTENTIAL OF INTERNATIONAL COOPERATION FOR THEIR SOLUTION

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Absract. The paper deals with some water management problems associated with the construction of large reservoirs in Siberia the solution of which calls for the involvement of international experience and cooperation of efforts of scientists and experts from different countries. To do this would require the use of scientific and organizational potential of single international programs such as "Clean Water – A Step Forward" (AASA) and World Water Program (IAP Water Program) and their joint efforts as well.

Природные условия строительства крупных водохранилищ на реках Сибири обуславливают масштабные и сложные изменения в окружающей среде. К числу важных водохозяйственных аспектов создания крупных и глубоких водохранилищ в условиях Сибири относятся вопросы прогнозирования состояния водной среды на зарегулированных участках реки – в водохранилище и нижнем бьефе. Так, в результате изменения гидроледотермического режима в нижних бьефах высоконапорных ГЭС в зимний период образуется незамерзающая полынья. Изменение температурного режима реки и условий газообмена влияет на речную флору и фауну и приводит к изменению самоочищающей способности реки. Эти воздействия гидростроительства на водную среду могут носить негативный характер и требуют предварительной оценки на этапе проработки экологических последствий реализации гидротехнических проектов.

К примеру, многие водохозяйственные проблемы, возникающие с различной степенью остроты при строительстве высоконапорных ГЭС в условиях Сибири, нашли свое отражение в вопросах, связанных с созданием Эвенкийской ГЭС на р. Нижняя Тунгуска. Так, природно-хозяйственные особенности территории затопления обуславливают безвозвратное изъятие части речной долины р. Нижняя Тунгуска, в которой проживает коренное население. Здесь проявляются также специфические проблемы создания сибирских водохранилищ, обусловленные недостаточной подготовкой их ложа перед затоплением, практически полным отсутствием лесосводки и лесоочистки.

Однако создание уникального водохранилища длиной только по основному руслу р. Нижняя Тунгуска в 1200 км и объемом около 409 куб. км (один из рассматриваемых вариантов строительства) обуславливает и весьма серьезные специфические проблемы, которые для своего решения требуют весьма серьезных научных проработок. Гидроузел планируется строить на 120-м км от устья на р. Нижняя Тунгуска – правом притоке Енисея. Климат региона резко континентальный; среднегодовая температура воздуха в районе строительства минус 8,5 ºС, ее минимальные зимние значения - до минус 63 ºС, максимальные летние – до плюс 37 ºС. Поэтому экологические проблемы создания Эвенкийского водохранилища в чрезвычайно суровых климатических условиях в большой степени замыкаются на прогноз ледотермического режима водохранилища и нижнего бьефа. Большую часть года водохранилище будет покрыто льдом и только в течение нескольких летних месяцев будет свободно от ледяного покрова. В настоящее время изменение качества воды в р. Нижняя Тунгуска при строительстве Эвенкийской ГЭС является весьма острым вопросом, в частности, из-за большого количества затопляемой древесно-кустарниковой растительности. Этот вопрос требует серьезного изучения и специальных исследований. Однако, принимая во внимание имеющийся опыт создания водохранилищ в северных и восточных районах России, а также зарубежный опыт, можно сказать, что затопление некоторого объема древесно-кустарниковой растительности при создании крупного водохранилища в северных условиях вполне возможно и не должно привести к серьезным и необратиным экологическим последствиям, представляющим опасность как для местного населения, так и для хозяйственной деятельности человека в нижнем течении р. Енисей. При решении этого вопроса целесообразно использовать опыт таких северных стран, как Канада, США (Аляска) и скандинавских стран. В частности, опыт затопления больших площадей лесной растительности при создании водохранилищ крупных гидроэнергетических систем компании Hydro-Quebec (the James Bay hydroelectric project) в провинции Квебек, а также в провинциях Онтарио и Манитоба в Канаде.

Развитие математических моделей гидрофизических, физико-химических и биологических процессов в глубоких внутренних водоемах имеет большой научный интерес для количественного прогнозирования состояния возникающих экосистем водохранилищ при строительстве высоконапорных ГЭС. В докладе рассмотрены результаты использования методов математического моделирования для прогноза изменения качества воды в р. Нижняя Тунгуска из-за строительства Эвенкийской ГЭС для разных вариантов выбора положения створа плотины и по этапам наполнения водохранилища. В выполненных расчетах учитывался прогноз изменений социально-экономических условий и условий хозяйствования на прилегающей к району строительства территории. Будут показаны проблемы использования математических методов, обусловленные, с одной стороны, ограниченностью знаний в соответствующей предметной области о моделируемых процессах, с другой стороны – с недостатком исходной информации из-за слабой изученности территории перспективного гидростроительства. На данном примере анализируются возможности кооперации международных научных усилий со специалистами из Бразилии, Китая и других стран, имеющими большой научно-практический опыт прогнозирования изменения качества водной среды в результате крупномасштабного гидростроительства.

Создание каскада водохранилищ на р. Иртыш существенно изменило гидрологический режим реки в связи с глубоким регулированием стока. Выполненные исследования выявили водно-экологические риски на трансграничных территориях в бассейне Иртыша, обуславливающие водохозяйственные проблемы сопредельных государств, решение которых возможно только с привлечением ученых и специалистов Казахстана, Китая и России.

Важное водохозяйственное значение имеет крупное равнинное Новосибирское водохранилище. Его создание привело к улучшению энергоснабжения района, водоснабжению г. Новосибирска, условий судоходства на р. Обь. Однако, как и на других равнинных водохранилищах, наблюдается постоянная переработка берегов, их подтопление, ухудшение условий самоочищения воды, Для решения данных проблем приходится проводить определенные мероприятия. Серьезные проблемы в эксплуатации Новосибирского водохранилища связаны с маловодными годами. Для прогнозирования приточности в водохранилище большое значение имеет изучение влияния природно-климатических изменений на формирование речного стока в бассейне Верхней Оби. Анализ этих факторов должен быть тесно увязан с использованием современных представлений об особенностях гидрологического цикла. Одной из важных конкретных задач, для решения которой следует использовать возможности международного сотрудничества, может быть разработка научных основ оперативного (краткосрочного) прогнозирования водного режима рек с целью изучения возможностей увеличения заблаговременности и повышения надежности таких прогнозов.

Ряд других важных водохозяйственных аспектов создания крупных водохранилищ в Сибири оказался за пределами данного доклада. Среди них особо следует отметить воздействие водохранилищ на гидролого-климатические условия прилегающей территории и абразионные процессы в береговой зоне водохранилищ. При строительстве водохранилищ в районах распространения вечной мерзлоты этот вопрос является трудным и важным. И здесь следует использовать потенциал международного научного сотрудничества.

Результаты, представленные в докладе, получены при поддержке Интеграционных проектов СО РАН 23, 82 и 95.

Strategic plan for the management of lakes and reservoirs in Malaysia

Shahrizaila Abdullah and Salmah Zakaria

1.0. Introduction

Lakes and reservoirs in Malaysia are natural or man-made. Common uses of these water bodies are for water supply for domestic, industrial and agricultural purposes; for hydroelectric power generation; for flood control; for navigation and for recreation. They are also home to diverse biological species and fisheries. Lakes and reservoirs are vital storage areas of the country's water resources.

2.0. Eutrophication of lakes study

A preliminary assessment on the status of eutrophication of lakes in Malaysia undertaken jointly by the Academy of Sciences, Malaysia (ASM) and the National Hydraulic Institute of Malaysia (NAHRIM) in the year 2005 reported that about 62% of 90 lakes that were studied were nutrient-rich or eutrophic while the balance was considered mesotrophic. This deterioration of water quality is a matter of serious concern.

3.0. Colloquium on lake and reservoir management

Following from the above study and as a first step towards dealing with the issues causing the degradation of this important "stock" of the country's water resources, ASM and NAHRIM (with support from the Ministry of Natural Resources and Environment (MoNRE), the Inter Academy Panel (IAP), and Japan Science and Technology Agency (JST)) organised a 2-day Colloquium on the Management of Lakes and Reservoirs in Malaysia held at MoNRE from 2nd to 3rd August 2007. The objectives of the colloquium were to:

- Create and foster greater awareness on the status and issues pertaining to lakes and reservoirs in Malaysia brought about by development in and around the lake environment.
- Share the findings of past and current research activities and taking stock of current lake management practices.
- Develop and set up a framework for sound lake management in Malaysia and for a continuing related research agenda.

The Colloquium was well attended, comprising some 120 participants made up of senior executives from the public and private sector, lake managers, Government officials, representatives from NGOs, researchers, and academics.

Eight case studies on specific lakes and reservoirs in Malaysia were presented by local managers and researchers while a keynote address and 3 other lead papers were delivered by foreign speakers from Japan (ILEC), Poland (ERCE), and Brazil (University of Sao Paolo)

Many useful findings and recommendations from the Colloquium provided the initial inputs for further action towards the formulation of a national integrated plan for sound and comprehensive lake management in the country.

4.0. Development of a strategic plan for lake and reservoir management

ASM and NAHRIM have since jointly established a Technical Committee on Lake Management with a view to follow-up on the recommendations arising out of the earlier Lake Colloquium held in August 2007 and with an express priority focus on the development of a Strategic Plan for Lake and Reservoir Management in Malaysia.

An action plan spread over a time frame spanning the year 2008 was allocated to develop and formulate such a Strategic Plan through a multi-stakeholder consultative process commencing with an initial Conceptual Framework Plan. This would be followed by preparation of more detailed Component Plans which would subsequently be synthesized and incorporated in order to further refine the earlier Conceptual Framework Plan. These collective inputs from the multi-stakeholder consultation process would form the basis for drafting the final Strategic Plan for Lake and Reservoir Development and Management for submission to Government for endorsement and subsequent implementation.

a) Conceptual Framework

The Conceptual Framework for Lake Management was developed following the first multi-sector workshop held at NAHRIM on 15th January 2008. The Logical Framework Approach (LFA) was utilized as the management tool for conducting the workshop which provided a step-by-step analysis of the prevailing situation and propose measures to be undertaken. Some 38 participants representing stakeholders from the public and private sector, NGOs, research and academia, working in 5 break-up groups, discussed six thematic aspects, namely Governance, Management, R&D. Capacity Building, Information Management, and Community stakeholder participation. Discussions were focused on issues prioritizing, objective setting, output setting, activities setting, required inputs & estimated budget. Some of the main issues and objectives identified for the six themes as tabulated below were found to be cross-cutting. These have since been consolidated into main issues and objectives

Issues	Objectives
Governance 1. Lack of national policy on lakes basin management and development 2. Lack of legislation, regulations and mandates on lakes basin management and development 3. Lack of enforcement 4. Leading to unclear agencies responsibilities (Overlap of power, Differences in approach)	a) Short Term 1. Set up special committee to incorporate lake management needs within existing water policy(ies) b) Long Term 1. To develop an integrated, proper and effective national policy on lakes basin development and management 2. To develop legislation and regulations on lake basin development 3. Identify a clear function each agency involve
Capacity Building 1. Lack Of knowledge in status of lakes , information and Insufficient transfer Of knowledge Technologies From international bodies to local government 2. Lack of awareness and commitments from political makers and public. 3. Current water/lakes management is too sectoral.-The identity and role of the Lakes managers not clear. 4. Lack of financial support for capacity building on lakes management. 5. Education system-curriculum does not include conservation of lakes.	1. Create database to increase knowledge and provide information. -Exchange the information between research institutions, private sectors, NGO, Local Government and international agencies. 2. Create awareness among civil society, water managers, decision makers and political master. 3. To identify and determine relevant lakes managers for every lakes basin. 4. Funding and allocation for capacity building on lakes management. 5. To incorporate water and lake management curriculum from primary to universities level.
Research Needs 1. Lack of will and awareness – uses and benefits of lake & reservoir in Malaysia 2. Lack of funding 3. No coordination in lake research 4. Lack of critical mass (Expertise) 5. Poor dissemination of finding (especially to decision makers) 6. Poor stakeholders participation in lake research	1. To enhance the awareness on the importance of lake research that benefits the public 2. To improve the funding mechanism and quantum for effective lake R & D 3. To enhance coordination for integrated lake research 4. To provide sufficient researcher/ expertise 5. To enhance the dissemination of research findings especially to policy makers 6. To enhance the awareness on the importance of lake research that benefits the public
Lake Management	

1. No management plans and proper action plans 2. Guidelines in lake management are unavailable 3. Lack of Enforcement 4. Lack of Funding	1. Develop management plans by the custodian (It can be PERHILITAN, PBT, Local authority and etc) 2. Ministries involved to develop the guidelines 3. Proper Enforcement Laws & regulations in lakes management to be formulated 4. Proper source of funding
<u>Information Management</u> Data Collection : 1. Centralization of Data 2. Outdated Data 3. Research Findings – publishing and sharing of research output 4. Lack of Information and Data 5. No Database to store information	 1. To Assign one implementing agency to set up the data repository, To centralize data, To avoid and reduce redundancy in research work 2. To archive and update the data frequently by the main agency (month to month) 3. To encourage researchers from various institutions (e.g. NGOs, Universities and Government Agencies) publish their lake management research findings. 4. To promote more research input 5. To Create a database to store research finding, To Develop application to store research finding e.g; Repository ,
<u>Stakeholder Participation</u> 1. Complacency towards responsibilities 2. Lack of awareness and knowledge Profit oriented mentality 3. Stakeholder conflicts	 1. Instill awareness through training, education, campaigns and various awareness activities 2. Effective empowerment for single society to look after their own backyard 3. To have conflict resolutions through forums

A matrix framework was provided to guide participants in considering associated verifiable indicators, means of verification and associated risks and assumptions. A completed sample format containing outputs from the discussion group pertaining to one of the objectives under the Governance theme is reproduced below:

ELEMENT	VERIFIABLE INDICATOR	MEANS OF VERIFICATION	RISKS/ ASSUMPTIONS
1. Main Objectives a) To develop an integrated, proper and effective national policy on lakes basin development and management leading to formulation of legislation, regulations and mandates.	The policy document is formulated	Hard and softcopy document forwarded through high level government channels and adopted by the government	Accepted and adopted by the government.

b) Component Plans

Following the successful development of an overall conceptual framework as described above, a fresh round of stakeholder consultations were held for each of the six themes in order to refine the earlier findings and formulate plans of action for each of the activities recommended. The target stakeholders invited for discussions this time around were those who are involved directly with or are associated with the respective themes.

At each theme component plan workshop session, a position paper on the topic that was commissioned earlier was presented followed by selected case studies of local experiences pertaining to the topic. This was followed by discussions in break-up groups again using the LFA format to address in detail the issues, objectives, outputs, activities complete with action plans.

The Component Plans developed at stakeholder consultation workshops held over the year 2008 are as follows:

- **Governance** – involved some 42 participants.
- **Management** – involved 67 participants
- **Research and Development** – involved some 30 participants
- **Capacity Building** –involved some 27 participants
- **Information Management** – Component Plan workshop deemed not necessary since NAHRIM has already acted on a comprehensive lake management information system. This computer-based sytem was introduced during the Management Component Plan Workshop with an

appeal to all lake managers to assist in populating and updating the database for the respective lakes under their control.

- **Community Stakeholders** –involved 31 participants

c) Strategic Plan for Lake and Reservoir Management

The reports of the Conceptual Framework Plan and six Component Plans were compiled from which a synthesis was undertaken leading to the formulation of a succinct Strategic Plan document for submission to Government The final strategy plan entitled the "Strategies for the development of Lakes and Reservoirs in Malaysia" has since been submitted to the relevant authorities in Government for adoption and implementation. In brief the Strategy Plan document essentially includes a set of recommendations with regard to four major interventions proposed as follows:

i. Development of a ***national vision for Malaysian lakes*** to drive a unified approach to lake management
ii. Early formulation and implementation of ***a policy framework*** to guide lake managemen'
iii. ***A mission statement*** to set the strategic goals, providing a sense of direction and to orientate strategies to achieved targeted outcomes.
iv. Development of ***a strategy framework for the development and management of Malaysian lakes*** to address key issues and ways to manage them sustainably in the Malaysian context. Strategies recommended include, among others, proposals for suggested institutional changes to support continuing integrated development and research activities, capacity building for effective integrated management at Federal and State level, stakeholder and community participatory management, strengthening existing legal framework, networking and enhancing regional and international cooperation.

5.0. Conclusion

The Lake Management initiative started in 2005 by ASM in close collaboration with NAHRIM has now developed into a clear programme to be pursued in an integrated manner and subscribing to ILBM principles and practices, which is in effect another sub-set of IWRM. The preparation of a Strategic Plan for Lake and Reservoir Management was undertaken through a multi-stakeholder consultation process to set the stage and direction for future concerted action by all stakeholders from both the private and private sector to ensure the sustainable development and management of the country's vital "stock" of water resources.

References:

ASM (2009). Strategies for the Sustainable Development of Lakes and Reservoirs in Malaysia, Academy of Sciences Malaysia, Kuala Lumpur.

ANTON, A. ZAKARIA, S. YUSOFF, F.M. LOW, K.S. LEE, J. SHARIP, Z. (2007). Proc. Col Lakes and Reservoir Management, NAHRIM, Seri Kembangan

UNESCAP (2008). Statistical Yearbook for Asia and the Pacific 2008. In Access to water and Sanitation, 77, Air and Water pollution, 191 and Water Use, 197.

AHMAD-RIZAL K (2007) Current State of the Environment in Malaysia, Proc, The 2nd International WEPA Forum, International Forum on Water Environmental Governance in Asia, Beppu, 2007

SHARIP, Z & YUSOP, Z (2007). National Overview 'Status of Lakes Eutophication in Malaysia" , Proc of the Colloqium …

NAHRIM (2005). Study on the Status of Eutrophication of Lakes in Malaysia

ASEAN (2005) State of Water Resources Management in ASEAN, 17, AUSAID, ASEAN-Australia Development Cooperation Program

Recent situation of water related problems in Japan basin

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Abstract. The growing need for knowledge about the dynamic behavior of sudden localized heavy rains, however, it is very difficult to observe and predict the behavior of such extreme events. We have been researching to find the reason of the growth and development of locally heavy rains to improve the weather forecast accuracy. This paper covers the following results of researches: Monitoring, experimentation and numerical simulation, this paper presents (1) there are four types of rainfall characteristics in Kanto region in Japan. (2) Applying the record breaking method to the rainfall events it was found that recent rainfall event using six observation points in Knato Plane in Japan recent rainfall is breaking a record based on 20 to 40 years of observation time.

Key Words **:** *radar image, record breaking ,observation time, rainfall analysis*

1. Introduction

Locally heavy rain happens frequently in Japan after the 1990's. According to report from Ministry of Land, Infrastructure, Transport and Tourism, it is shown that both generation frequencies of rain of the rainfall of 50mm or more in one hour and of 100mm or more in one hour are in the increasing tendency, and rainfall 50mm or more in one hour happened 313 times a year on the average, and rainfall 100mm or more in one hour happened 5 times a year on the average from 1997 to 2006. In such a situation, the Ministry of Land, Infrastructure and Transport and the Meteorological Agency organized a network of large-scale rain observation such as AMeDAS or Radars for rain observation. As a result of these systems rain prediction in meso α scales have improved. However, it is difficult to forecast locally heavy rain because it happens locally and in a short period of time. So as a first step of the forecast technique establishment, it is necessary to clarify the feature of the movement and the generation of a thunderstorm rainfall of the Meso β scale and rainfall of α scale that can bring locally heavy rain.

In our laboratory, Since X-Band Doppler radar was installed in the Chuo University Korakuen campus in 1995, we have observed the rain which happened in range of 128km in radius around Tokyo area. The positions of observation point were shown in Fig.1. The performance of Doppler radar was also shown in Tab.1.

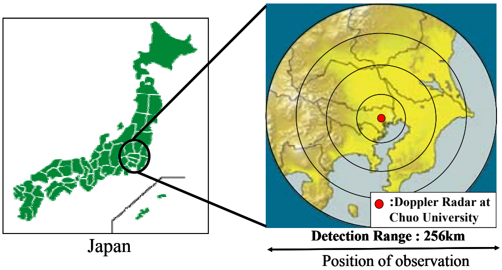

Fig. 1 Observation area

	Intensity Mode	Doppler Mode
Transmitted Frequency	9445MHz	
Pulse With	0.9μ s	0.45μ s
Repetition Frequency	1000MHz	2000MHz
Detection Range	128km	64km
Resolution	250m	125m

Tab.1 Performance of Doppler radar

2. Recent Heavy Rainfall event reported in Japan

Locally heavy rainfall in Kinki region and Hokuriku region (July 28, 2008)

Locally heavy rainfall was generated in the Kinki region and the Hokuriku region in July 28, 2008. **Fig.2** shows the radar image in the Kinki region on this day (July 28, 2008 14:40 P.M.). The front on the Sea of Japan moved towards south, and dumped humid air from south into this front. This system caused locally heavy rainfall in Kinki region and Hokuriku region. The water level rose by 1.3m in 10 minutes in Toga River in Hyogo Prefecture. Due to this locally heavy rainfall, 5 people including children were thrown into the muddy stream and found died. Asano River located in Ishikawa Prefecture Kanazawa city was also flooded, and around 2000 houses were inundated.

August 2008 Heavy Rainfall

From August 26 to August 31, the August 2008 Heavy Rainfall caused damages throughout Japan especially in Chubu and Kanto region. **Fig.3** shows the radar image in Chubu region on this day (August 28, 2008 01:25 A.M.). Low pressure approached Kyushu area from August 26 to August 27, and the front slumbered from August 28 to August 31 above Honshu. Humid inflow from the south caused a locally heavy rainfall in this area. On August 29, hourly rainfall of 146.5mm and daily precipitation of 302.5mm were recorded in Okazaki City in Aichi Prefecture. In Kanto region, hourly precipitation on August 30, form 18:15 to 19:15 were 105.0mm in Abiko City in Chiba Prefecture. In Chubu region, 3 people were killed and around 4000 houses were inundated. From the July 28, 2008 and August 26 to 31, 2008 rain event cumulonimbus clouds formed a line shape. As a result of this the cumulonimbus clouds gripped in certain points delivering a large amount of rain in this area.

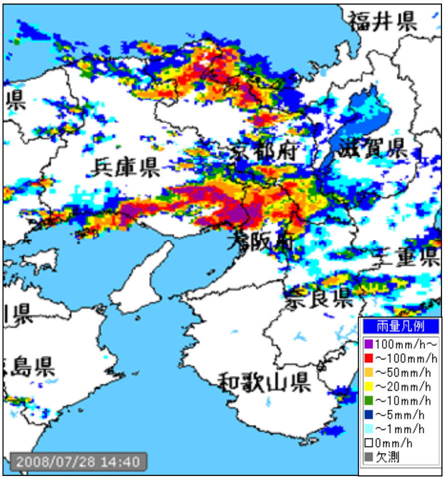

Fig.2 Radar image of Kinki region (July. 28, 2008 14:00) (Reference: Foundation of River and basin Integrated Communications)

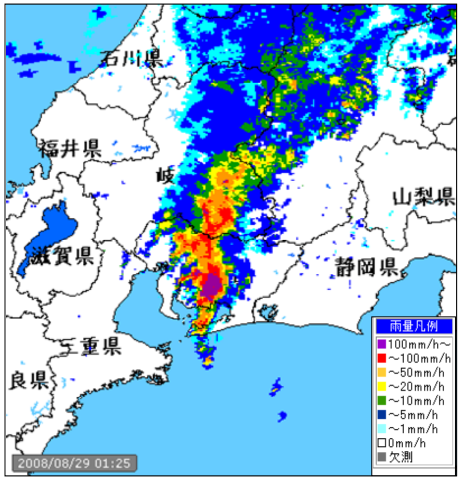

Fig.3 Radar image of Chubu region (Aug. 29, 2008 01:25) (Reference: Foundation of River and basin Integrated Communications)

3. Characteristics of Kanto region rainfall

As a result of analyzing the observed data for 15 years in the past, we found that there are four patterns of rainfall which brings locally heavy rainfall. Guerrilla downpour occurred frequently in Japan in recent years. These rainfall events brought heavy rainfall over area of a few to a dozen kilometers and disappear from generation in about one hour. Guerrilla downpour can be classified in three patterns: a) Front formation-type; b) Cells advection-type; and c) Isolated cell-type. These three patterns are occurring in the rainfall phenomenon which rainfall scale of 20km to 200km. Meanwhile, locally heavy rainfalls which deliver significant rainfall over a wide area for an extended period appear in the form of d) line-shaped convection system. This fourth pattern locally heavy rainfall occurs in rainfall phenomena with a rainfall scale of 200-2000 km which similar to front or low pressure system. We will next describe the features of each rainfall pattern.

3.1. Front formation-type

These type rainfalls generate in the northern or western mountainous area around Tokyo area, and advect to Tokyo bay with forming frontal rain band. Front formation-type rainfall causes the ascending current by rising sea breeze in boundary layer, or the collision with sea breeze and wind blowing down the mountain generates the front formation-type rainfall. **Fig.4** shows that the rain band growing as line advects southeastward at the point after one hour.

3.2. Cells advection-type

Fig.5 shows an example of radar images on the cells advection-type rainfall. The rain band of this rainfall in a belt extends to the same direction which precipitation cells are advected. Precipitation can detect in a broad area in the Kanto plain.

3.3. Isolated cell-type Rainfall

The radar image in **Fig.6** shows that a instantaneous rainfall intensity of heavy rain generating rain band with 5-15km around is over 64mm/hr. We named this rainfall isolated cell-type rainfall. Comparing this rainfall with the previous two rainfall types, the scale of this rain on time and space is also smaller. A point of generation in this type is a wide area and consecutive. As mentioned on static stability of the front formation type and the cells advedtion type.

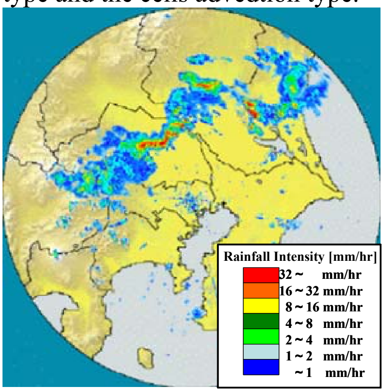

Fig.4 Radar image of front formation type

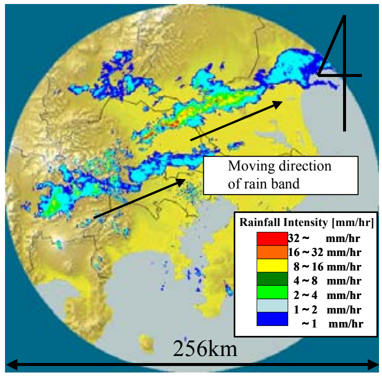

Fig.5 Radar image of cell advection type

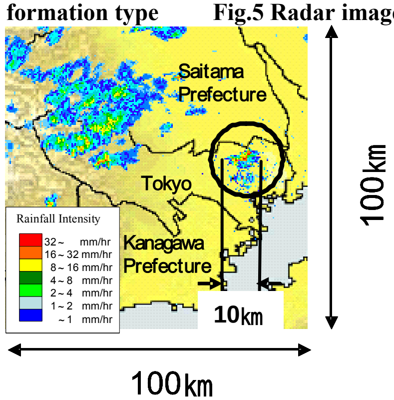

Fig.6 Radar image of isolated cell type

3.4. Line-shaped convection system

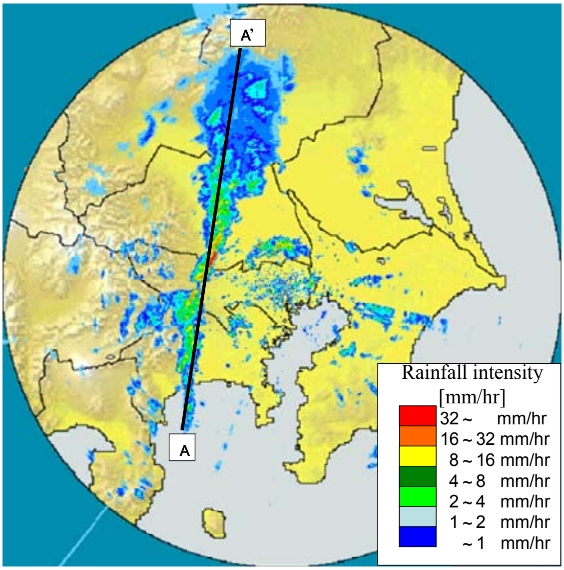

Fig.7 Radar image of line-shaped convection system

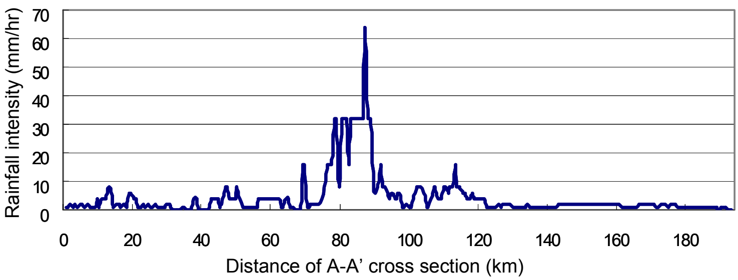

Fig.8 Relationship between rainfall intensity and horizontal distance of A-A' cross section of Fig.7

In this type of torrential rain, the cumulonimbus exists like a line, while absorbing and annexing the cumulonimbus newly generated and remaining stationary for a long period. **Fig.7** is a radar image of locally heavy rainfall caused by a line-shaped convection system. The width of rainfall area is 15 km and length of that is 100 km and stay for three hours and dumped heavy. **Fig.8** shows that the rainfall intensity of the a-a'cross-section of the rainfall area shown in **Fig.7**. The size of the rainfall area where rainfall intensity exceeds 32 mm reaches 10 km or more. From this result, line-shaped convection system can bring heavy rain in wide range, so the possibility of having a great damage is high.

4. Deriving of theory of appearance of record breaking

When the rainfall is observed in given year in the past, focus on the greatest record of each year. The greatest record which was observed in the first year of observation is a new record

If a statistical characteristic in every year does not change and best record of each year follows the same continuous distribution, the probability that the best record which was observed in the i th year becomes a new record is 1/i.

The reason because the observed data in the first year, second year, □, i th year are equally probability, and its probability is 1/i. Then, define random variable X_i as follows.

$X_i = 1$: When greatest record which was observed in the i th year is a new record.

$X_i = 0$: When greatest record which was observed in the i th year is not a new record.

These probabilities are independent

$P\{X_i = 1\} = 1/i$, $P\{X_i = 0\} = (i-1)/i$

and the expected value and variance are described as

$E(X_i) = P\{X_i = 1\} = 1/i$

$V(X_i) = E(X_i^2) - E(X_i)^2 = P\{X_i = 1\} - P\{X_i = 1\}^2 = (i-1)/i^2$

Then, number of record breaking for n years is

$R_n = X_1 + X_2 + \cdots + X_n$

These expected value and variance are described as follows (Takeuchi et al., 1988).

$$E(R_n) = 1 + 1/2 + \cdots + 1/n$$

$$V(R_n) = 1 + 1/2 + \cdots + 1/n - 1 - 1/2^2 - \cdots - 1/n^2$$

Fig.9 shows that the relationship between observation time and expected value and variance of number of record breaking. In about 100 years the number of record breaking is about five times and in about 200 years the number of record breaking is about six times. Frequency of appearance of record breaking by the observed rainfall data

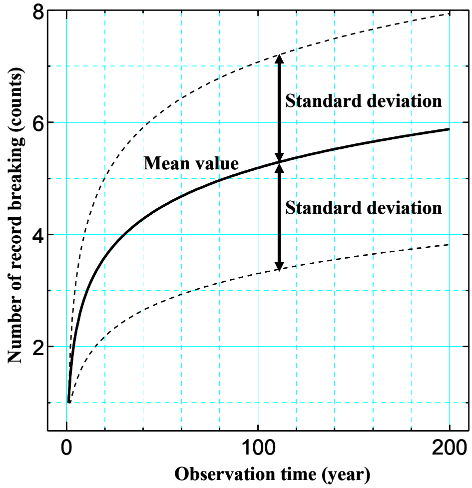

Fig.9 The relationship between observation time and expected value and variance of number of record breaking

4.1 Frequency of appearance of record breaking by the observed rainfall data

In this chapter, the theory of appearance of record breaking is applied to the observed rainfall data. **Fig.10** shows the example how to set up a record breaking number per certain observation time. The upper graph shows daily maximum rainfall in time series. The next graph shows that the annual maximum values are selected and plotted. Under that graph, there are observation time sample frame. In this frame, the record breaking number will be counted in observation time n years which is shown as a in the figure. In the bottom plotted graph shows the number of record breaking. This is how record breaking number is counted.

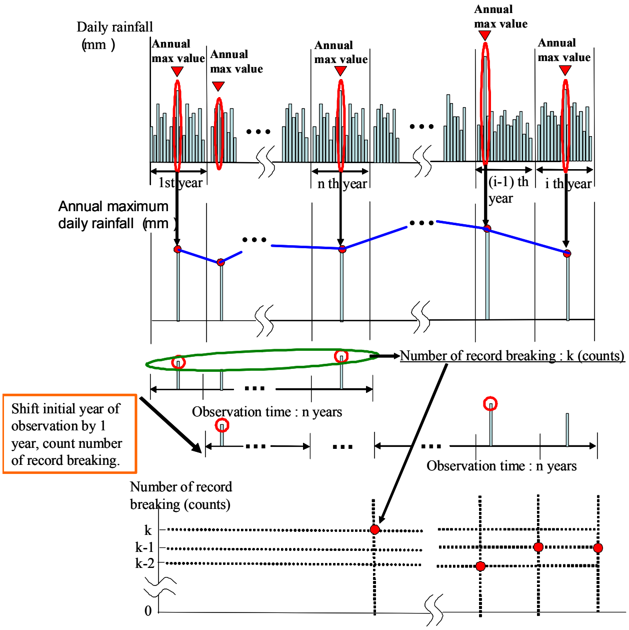

Fig.10 The concept of how to set up a record breaking number per certain observation time

4.2 Difference of the record breaking number between the different observation times

In this section the observed data from Tokyo is used. **Fig.11** shows the annual maximum daily rainfall time series. From this figure it can be said that in 1950s the maximum daily rainfall was under 200mm/day except in 1958 where the maximum daily rainfall was over 300mm/day.

Fig.12 and **Fig.13** show a number of record breaking using different observation time. In **Fig.12** is 20 years, and **Fig.13** is 50 years.

Form those figures it can be said that in 20 years observation times show an upward tendency from late 1990s. On the other hand, observation time in 50 years show a downward tendency throughout the whole period.

These two different trends are due to the 1958 extreme rainfall event. 20, 30, and 40 years observation times graph show that the number of record break decreased in the 1980s and 1990s. This is because the 1958 rainfall is no longer in the observation time. After 1985 the maximum daily rainfall reached the new record every other year. This is the reason that the recent record breaking number is increasing.

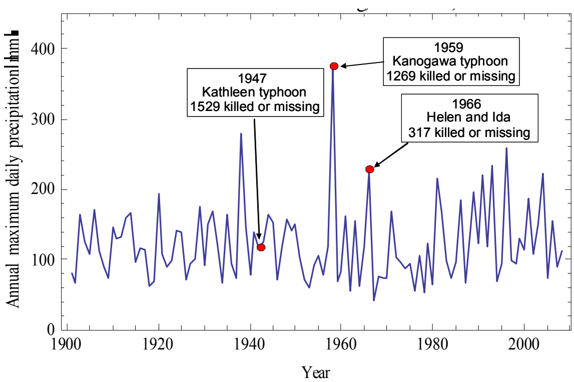

Fig.11 The annual maximum daily precipitation time series

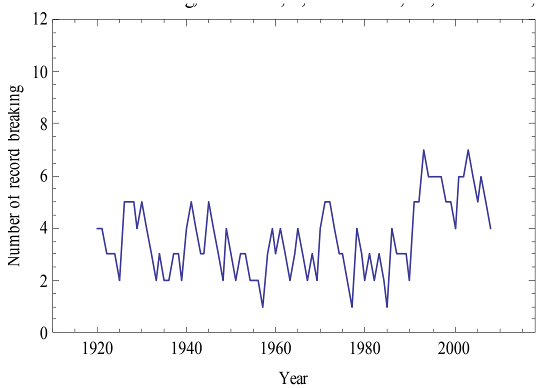

Fig.12 Time series of record breaking using 20 years observation time in Tokyo

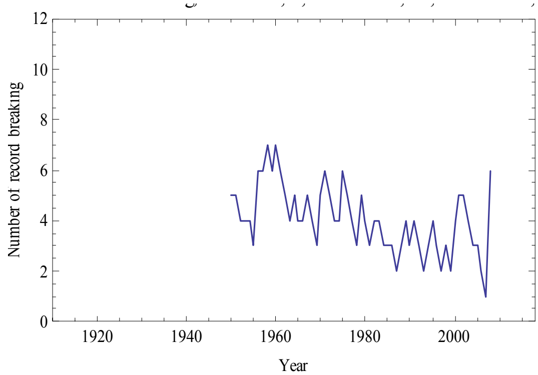

Fig.13 Time series of record breaking using 50 years observation time in Tokyo

4.3 Comparison between maximum observed data among six observed points and the six different observed points

In this section the observed data from Kumagaya, Maebashi, Mito, Tokyo, Utsunomiya, and Yokohama are used to find a trend for the record breaking.

When you have a multiple observed points, it is possible to compare and choose the largest value among the multiple observed points. **Fig.14** shows the concept of how you choose the largest data from different observed points. As you can find in the bottom of the figure the new time series consists of maximum value among the several observed points (there are n points here) which was used in the previous section.

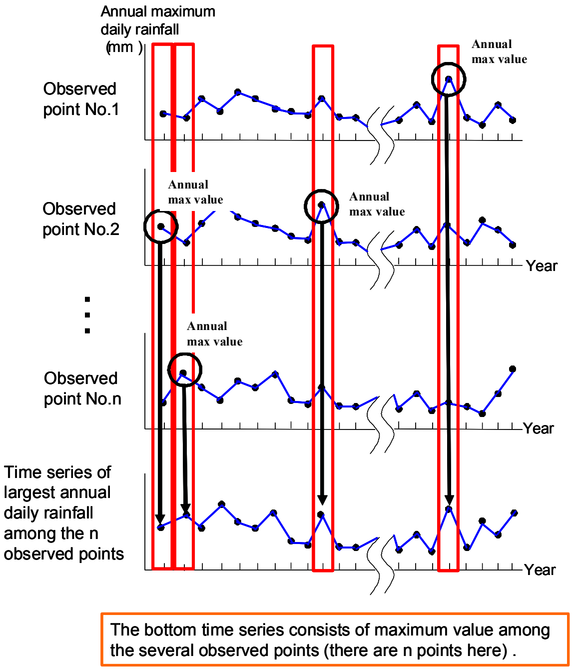

Fig.14 The concept of how to choose the largest data from different observed points.

Fig.15 shows a time series of largest annual daily rainfall among the six observed points which was already shown in previous section. Comparing with **Fig.11** the larger values appear more often than in the **Fig.15**.

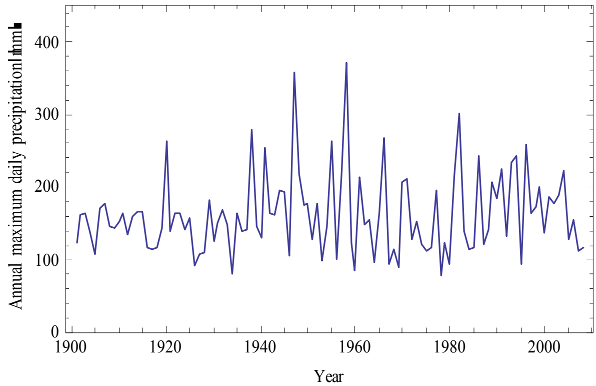

Fig.15 Time series of largest annual daily precipitation among the six observed points

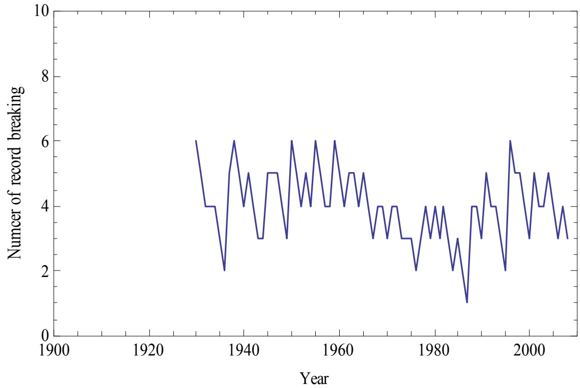

Fig.16 Time series of record breaking using 30 years observation time using maximum rainfall data among six observation

The same process can be taken to this time series and the number of record breaking in different observation times in 30 years and in 50 years are shown in **Fig.16** and **Fig.17**. The trend in those figures are almost the same with the time series of record breaking using 30 years observation times and 50 years observation times in Tokyo.

Fig.18 compares the mean value of record breaking using the largest value among six observed points and the mean value of record breaking number from six different observed points. It can be said that there is almost no difference between these two lines (black and red lines).

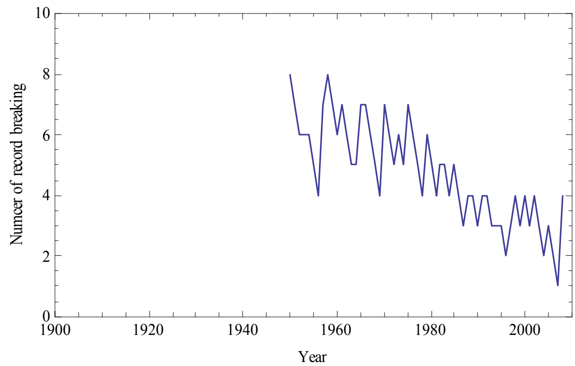

Fig.17 Time series of record breaking using 50 years observation time using maximum rainfall data among six observation points

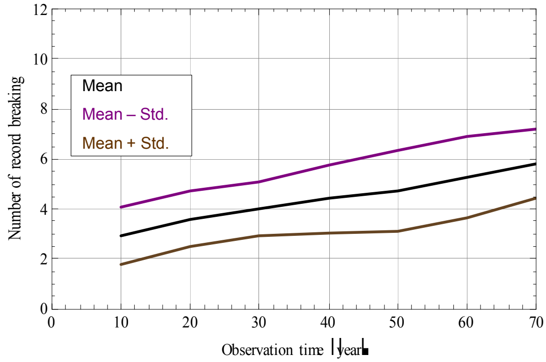

Fig.18 The number of record breaking of largest annual daily precipitation among the six observed points in different observation points

5. Conclusions

(1) Judging from the shape of the rainfall area and the moving configuration, locally heavy rain is classified into four types (front formation-type, cells advection-type, isolated cell-type and line-shaped convection system).

(2) The theory of appearance of record breaking was applied to the rainfall events observed in Kanto area. The difference in observation time delivers a great difference in recent trend in rainfall. 20 years to 40 years observation times show an upward tendency from late 1990s. This is not due to the number of observation points in Kanto area.

(3) The number of record breaking using the mean value of largest value among six observed points and the mean value of record breaking number from six different observed points are virtually united with three different observed data which is annual daily rainfall, annual hourly rainfall, and annual 10minutes rainfall. This is another reason that the recent record break is not due to the number of observed points

REFERENCES

1) Etoh, T., Murota, A.., Yonetani, T., Kinoshita, T.: Frequency of Record-Breaking Large Precipitation, Journal of the Japan Society of Civil Engineers, No.369/II-5, pp.165-174, 1986. (in Japanese)
2) Sogawa, N., Araki, M., Uehara, T., Kusakari, T.: Reliability Evaluation on Estimated Parameters of Gumbel Distribution, Journal of the Meteorological Society of Japan, Vol.38, No.8, pp.3-9, 1991.(in Japanese)
3) Yamada, T., Hibino, T., Araki, T. and Nakatsugawa, M.: Statistical Characteristics of Rainfall in Mountainous Basins, Journal of Japan Society of Civil Engineers, No.527/II-33, pp.1-13, 1995.11 (in Japanese)
4) Wtanabe, T., Yamada, T. and Shinagawa, M.: A Study on frequency and recurrent year of Heavy Rainfall Based on Theory of Apparition of New Record, Journals of Japan Society of Hydrology and Water Resources, 1992. (in Japanese)
5) Wakigawa, K. and Suetugu, T. : Study on Effective Damage Reduction Measures for Smaller Rivers., Annual Journal of Advances in River Engineering, Vol.11, pp.19-24, 2005. (in Japanese)
6) Masayuki Maki , T. Maesaka , K. Iwanami , R. Misumi , A. Kato , S. Suzuki , S. Shimizu , K. Kieda , T. Yamada , H. Hirano , T. Kato , F. Kobayashi , H. Hiraguchi , K. Kusunoki , A. Masuda , Y. Suzuki , T. Moriya , D.-S. Kim , D.-In Lee (2008) X-band Polarimetric Radar Network in the Tokyo Metropolitan Area , International Workshop on the Hazardous Winds Associated with Severe Storms
7) T.Yamada (2008) Integrated Analysis for the Water Cycle Simulation Based on Hydro-Meteorology, EWRI Congress 2008
8) Eito,H., M.Yoshizaki, M.Fukuda, Y.Fujiyoshi, A.Inokami, T.Igarashi and members of X-BAIU-99 observation (1999) Case study on the structures of two line-shaped convective systems observed around Nagashima on 2 July 1999(in Japanese). Proc. of the Autumn Conference of Japan Meteor, Soc., 75, 100
9) R.Misumi, M.Divjak, S.Tanahashi and T.Takeda (1994) A numerical study on the formation of organized convective storms: Part I. Formation patterns of long-lasting cells, Journal of the Meteorological Society of Japan, 72, 235-253
10) R.Misumi, M.Divjak, S.Tanahashi and T.Takeda (1994) A numerical study on the formation of organized convective storms: Part II. Dependence of "broken-line formation" of squall-line on its line direction, Journal of the Meteorological Society of Japan, 72, 873-884
11) Shimizu S., H. Uyeda, Q. Moteki, T. Maesaka, Y. Takaya, K. Akaeda, T. Kato, M. Yosizaki (2008) Structure and Formation Mechanism of a 24 May 2000 Supercell-like Storm Developing in a Moist Environment over Kanto Plain, Japan. Monthly. Weather. Review. 2008, vol.7, 2389-2407
12) National Research Institute for Earth Science and Disaster Prevention (2007) Proceedings, International Sympojium on X-band Weather Radar Network – Challenge the Severe Storm-, Tukuba, Ibaraki 1-83

For notes

Scientific edition

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