INTRODUCTION. IRRIGATION AND DRAINAGE DEVELOPMENT IN THE REGION

Central Asia is one of most ancient regions of irrigated farming development. Irrigated agriculture existed in this region 4 thousands years ago. Local population used for irrigation territories located in deltas and flood plains of small and middle rivers and streams which did not require for water diversion complex structures and canals of big length. Before XX century irrigated area exceeded 3 mln ha.

Irrigation and land use methods were different. Oasis irrigation in the upper and middle reaches mainly on base of local sources was well balanced. Naturally drained not subjected to salinization and waterlogging lands were used and water was used economically. Different farms, mainly small in size, widely used water rotation reaching high level of water use. This is proved by study conducted by bureau of land improvement under leadership of A. Kostyakov (1903-1905).

At the same time, on the alluvial plains of middle and lower reaches large water structures had place (Gavhor canal in Khorezm, Shah-Sepen in Kunya-Urgench, Shahrud and Dargom in Zearfshan valley, Kuinly in the Aral side) with discharge of 200 m^3/s with water diversion from AmuDarya and SyrDarya and a lot of off-takes (engineering aand local type).

Delta and adjacent irrigation systems were well developed and widely used "dry drainage" to fight soil salinization. Lands were irrigated in checks and specific discharges were significantly lower.

Turkestan colonization by tsarist power was accompanied by planned development of irrigation systems in order to develop irrigation and make this region the base of cotton growing periodwing. At that time project of development of Golodnaya steppe, Fergana valley, Karakum canal zone were prepared and some of them were implemented (Golodnaya Steppe, Fergana, Chu valley, etc.).

Simultaneously, the first steps were made in old network reconstruction (state farm in Bairam-Aly, ZolotoOrda region in Golodnaya steppe, etc.

New lands development in the Aral sea basin, started by Zarist Russia by the end of XIX century, was widely spread under the soviet power. If before 1913 irrigated areal was 3250 th. ha, by 1940 it was 4.3 mln ha and in 1960-5 mln ha. Land development was executed at expense of internal fallow lands in old irrigated massifs as well as new lands in Golodnaya, Dalverzin steppes and Fergana, Vachsh and Chu valleys, South Kazakhstan and Turkmenistan. Large geomorphological-hydrogeological structures were used characterized by complex and very complex natural-climatic conditions: river valleys, inter-mountain bowls, upper and lower terraces of the rivers, cones of withdrawal and large river deltas. Irrigation of such natural structures required to solve complex problems: river flow regulation by water reservoirs and water -intakes reservoirs construction, huge inter-farm canals, on-farm irrigation-drainage systems.

Irrigation systems established in 1955-1960 have engineering base. But, on the one hand, this network has being constructed in earthen channels, allowing huge water losses during its delivery and, on the other hand, without respect to peculiarities of natural conditions geochemical flows and zone of natural salt accumulation, within which irrigated massifs were developed. Irrigation systems efficiency was 0,5-0,55. Widely developed network of gravity irrigation over the area more than 7 mln ha by large irrigational canals with discharge up to 700 m^3/s and length 1400 km (Karshi Steppe) and water rift on the area of 2 mln ha led to natural water-salt balance breakage and ground water table lift was strengthened, which led to soil secondary salinization in many regions of Central Asia. Measures under taken in 1950-

1960 on prevention of land water logging and secondary salinization on base of strict system of water use and leaching irrigations on background of open drains and collectors did not give any results. Land and irrigation water productivity reduction was observed as a consequence of land water logging and salinization.

By 1990 irrigated area achieved 7,4 mln ha. By January 1, 1999 irrigated area in the Aral sea basin is evaluated as 7,95 mln ha under total area of possible irrigation 32,6 mln ha. 70-75 % of developed lands were presented by saline or subjected to salinization soil. Practically all developed during last 40-50 years irrigated lands are supplied by irrigation -drainage network meeting modern requirements to land reclamation.

It worth to note, that starting since the middle of 50-es over old irrigated lands middle-scale measures on reconstruction of irrigation -drainage systems and saline land reclamation were conducted. Irrigation systems include unique cascades of canals with water lift height up to 180 m and discharge up to 350 m^3/s and gravity canals with discharge in the head part 700 m^3/s.

By 1999 total length of mains and inter-farm canals was 47,748 km (specific length 17,93 m/ha) from which 13,5 th km (28 %) are covered with lining, 77 % of water -intakes on these canals is equipped by watermeters. Inter-far irrigation systems efficiency in the region is on average 0,77 and varies over republics from 0,62 (Tadjikistan) to 0,83 (Kazakhstan and Uzbekistan). Total extent of on-farm irrigation network is 268 480 km. Only 21 % of them or 60300 km are flumes, close pipelines and lined canals. Specific extent of on-farm irrigation canals varies from 18 m/ha (Turkmenistan) to 40 m/ha (Kazakhstan and Uzbekistan). Average-weighted efficiency of on-farm systems is 0,73, efficiency of irrigation systems as a whole is 0,54-0,64.

On-farm systems sharply differ each other in respect of technical equipment, depending on stages of development. Systems constructed during last 35-40 years consist of flumes, lined canals, pipelines and have efficiency 0,82-0,85. Lands developed before 60-es have earthen canals with efficiency 0,7-0,75. In Central Asia 5,2 from 7,956 mln ha irrigated lands require artificial drainage because of soil secondary salinization and waterlogging.

These areas are spread all over Central Asia: on cones of withdrawal, central parts of inter-mountain bowls, on periphery of dry channels and river valleys, which have non-drained or low drained soils with highly saline ground water. It worth to take into account , that all Aral-Caspian depression, according to famous pedologist V. Kovda and V. Yegorov, is the place of salt accumulation and salt water solution seepage which are accumulated in soils and ground waters.

In conditions of developing irrigation which is imposed on stabilized mass of salts and saline water, consequences of natural water and salt exchange processes violation appeared especially in zones with shortage or absence of ground water outflow leading to ground water salinity changes; secondary ground water head creation, salt accumulation and secondary soil salinization strengthening, and as a result, salt disposal into the rivers and sinks.

Nevertheless, understanding of all these difficulties has led, in the second half of XX century, to engineering construction and drainage system development within the irrigated lands.

Active fight against significance was started; meaningness of reclamation measures as combination of irrigation and drainage parameters; design and implementation of the systems and their background, successful soil leaching of initially saline as well as secondary salinized lands. As a results of all these measures 4,7 from 5,2 mln ha are provided by artificial drainage. By 1.06.1996 there are 174,5 th km (39,4 m/ha) of horizontal drainage (including 145,4 th km on-farm drainage) and 8650 wells of vertical drainage.

Average command area for 1 well is 85,5 ha under maximum 250-300 ha. Total area of close horizontal drainage is around 600 th ha from which 581 th ha belong to Uzbekistan. In other countries of the region subsurface drainage was practiced only in "pilot stage".

Specific feature of water-reclamation work in 1960-1990 is creation on all massifs pilot plots on all kinds of drainage and irrigation before projects implementation. On these plots wide-scale investigations were conducted to justify design decisions, irrigation-drainage systems parameters sustainability and efficiency as well as tendency in ecological-meliorative processes and possibility to manage them on base of existing technical means.

350-450 pilot plots were constructed within the basin and they encompassed all natural-economic conditions of the region. Plot area was from 50-10 up to 1000-2000 ha but sometimes all farm or irrigation system were covered by experiment. Plot of minimum size were dedicated to crop irrigation regime study, soil desalinization technique and technology, technique of irrigation and water saving management of ecological-meliorative processes, drainage parameters and efficiency were studied on area 500-1000 ha. According to results of these studies corrections were made in design of future objects.

Such an approach allowed to rise technical level of irrigation-drainage systems which was much higher compared with systems being constructed in 1950-1955. Main advantage of meliorative system created in Central Asia during last 35-40 years with respect to national and foreign experience that these system are capable to manage ecological-meliorative processes and permit to achieve irrigated lands and irrigation water productivity increase.

These systems allowed:

- to reduce specific water supply by 1980 to 17,6 and by 1990 to 14,7 th m^3/ha versus 21-27 th m^3/ha in 1955-1960; on perfect irrigation system meeting modern requirements in water saving (Golodnaya steppe), irrigation norm was 9,5-10,5 th m^3/ha in new zone and 10-12 th m^3/ha in old one;
- to create in all regions of artificial drainage drainability meeting requirements for saline soil reclamation. Drainability varied within 2,5-3,0 and 6-7 th m^3/year that permitted to manage soil water -salt regime and reach meliorative and economic effect. Under normal drainage systems operation and following leaching regime of irrigation negative water-salt balance with salt removal from 5-10 th/ha. Highest effect is observed where perfect types of drainage are constructed: Fergana, Vahsh, Chu valleys, Golodnaya steppe, Bukhara Oasis, SyrDarya lower reaches (Kzylkum massif). Here within few years of drainage operation aeration zone soil and ground water desalinization is achieved, that allowed to increase irrigated land and irrigation water productivity.

During the years of the highest yield of agricultural crops achievement irrigation water productivity for cotton varied within 0,35-0,70 kg/m^3 versus FAO criterion 0,4-0,6 kg/m^3. Similar results were obtained for other agricultural crops:

internal gross production over Uzbekistan regions varied from 1200-1300 (Karakalpakstan) up to 1900-2000 ruble/ha (Surhandarya).

But starting since 1985-1990 irrigated lands productivity reduction is observed by 1,5-2 times versus 1980-1985 and on 5-40 % versus 1990. Main reasons for this phenomena were as follows:

- farms potential and assets decrease;
- input prices increase, especially fuel and agricultural machinery;
- weak infrastructure and financial system;
- irrigated lands meliorative state aggravation due to low workability of irrigation-drainage systems, especially on-farm ones, because of full or partial of refusal state to contribute in operation and maintenance of on-farm network.

Violation of leaching irrigation regime and unproductive use of scarce water resources, especially at on-farm level, affected irrigated land meliorative state. It worth to note, that inspite of relatively high technical level of new and modernized reclamation system under development of new and reclamation of old lands, certain mistakes were made, in result of which Aral sea crisis arose, which main features were: water resources depletion and pollution, land and water resources productivity reduction, desertification, losses of volume and productivity of Aral sea itself, etc. Main reason was large-scale land development and reclamation without respect to possibility of own water resources depletion.

Decisions about possibility and expediency of any categories of land reclamation on base of artificial drainage, leaching and leaching irrigation regime accelerated violation of ecological equilibrium in the region. Such way of land development without water saving technologies under conditions of Central Asia led to high water expenses.

While many ecological and socio-economic problems of Central Asia are connected with water resources scarcity, their poor management, agricultural and industrial production short-comings, main ways to stabilize ecological equilibrium and socio-economic stability is development of common strategy of land and water resources use and management. This strategy should be based on wide introduction of measures on water saving and nature conservation. Main principles, decisions, water saving technologies and technique should be justified in pilot projects on representative areas. But necessity of development of these technologies under conditions of transfer to market economy does not mean necessity to study everything "ab ovo". Huge experience accumulated in Central Asia and rather strong in the past water -related organizations allowed to study natural and antrophogenic processes in their interrelations: to investigate possibilities of minimum water diversion from sources (surface and ground water): to assess different methods of meliorative processes acceleration and water and land use.

Taking into account that all previous studies are unknown to the most of foreign specialists assisting the region by their experience, the World Bank has agreed to prepare the project "Evaluation of the previous pilot projects on irrigation and drainage in Central Asia".

Authors assume that necessity of this evaluation could be explained as well by necessity to provide next generation of the local specialists with this knowledge. Last time the most specialists graduated from the institutes do not know the findings and experience being gained 10-20 years ago.

When the World Bank has known about plenty o pilot projects in the region the contract between ECIFAS and the World Bank was signed in 1997 in order to summarize results of these projects.

Main tasks established by Terms of Reference was information collection and transformation according to IPTRID Register Format.

The following directions of research were determined:

- improvement of water use at inter-farm and on-farm level trough irrigation and leaching regime perfection (water consumption norm identification);
- management of water-salt regime and ecological-meliorative processes on background of drainage systems, leaching and leaching regime of irrigation;
- summary of field investigations on drainage water re-use in places of its origin;
- summary of experimental studies of optimal methods of irrigation, irrigation technique and technology parameters.

In 1997 tender was announced, in which 15 scientific-research institutes took part. Information on 250 pilot project was submitted. 143 pilot projects were selected for analysis.

Authors were forced to use additionally grey literature from SIC ICWC and SANIIRI libraries as well.

Further this information will be circulated among the local and foreign specialists for comments.

This report is review was executed by Mr. R. Ros, who made significant correction. Authors hope to prepare publication of this information with his assistance. Any comments and amendments would be appreciated.

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