Problems and Perspectives used Groundwater Sources in Case of Emergency and Projecting the Drainage in Arid Zone of Central Asia

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ABSTRACT

By the end of 19th century there were some 7–8 million people in the region. Irrigated land amounted to about 3.4 million hectares and was equipped by an irrigation network. Today the region’s population has increased seven fold, and irrigated areas have broadened twice—up to 7.5–7.7 million hectares. Arid climate and irrigated nature contribute to land and pasture land degradation, which leads to significant decrease of agricultural productivity. Significant parts of irrigated areas are subject to salinization, which is 16% and above in Tajikistan, up to 30% in Kazakhstan and about 70% in Turkmenistan. Therefore, the major tasks in the field of melioration and obtaining the supplementary sources of irrigation water has great importance.

1 INTRODUCTION

In Central Asian Region (CAR) water is one of the most important factors defining the possibility for life and development in an arid zone.

New independent states of CAR acquired independence in 1991, namely, the Republic of Kazakhstan, Kyrgyz Republic, Republic of Tajikistan, Turkmenistan and Republic of Uzbekistan. General area of region territory is about 3882 thousand Km² with the population of more than 53 million people.

In each and every individual case the possible complex of measures and their mutual combination must be defined in view of natural conditions, technical economic purpose
On old-irrigated grounds, basic mass of underground waters, formed on them, makes horizontal moving on well washed out pebbles without essential change of a degree of mineralization and chemical compound.

The significant area of spreading powerful pebble water-bearing horizons provides an opportunity of creation in them practically of unlimited adjusting capacity. Preliminary in them operating a level of underground waters on 5-10 m and more can ensure adjusting capacity, in most cases quite sufficient for use water-bearing pebbles of horizons as underground reservoirs for seasonal and of many-years regulation of a drain of yet not used part of superficial waters (plenty of flood waters and not vegetative the period).

Water-bearing horizons in pebbles, described raised water-permeability, large square spreading and significant total powerfulness, practically provide an opportunity of development of a wide network of high-efficiency chinks of a vertical drainage and centralized economical drinking water supply. Debit of them can make from tens up to 100-200 L/sec and more, and effect drainage many tens and hundreds ha.

On the basic objects of irrigation of Northern Tajikistan and Kizilsu-Yakhsu valleys, the network of such chinks can supply the most economic joint decision (in comparison with machine irrigation in a combination with horizontal drainage) tasks on melioration of irrigated grounds and covering of deficiency in irrigated to water. On the water-supplied objects of irrigation, requiring in land improvement of the salted grounds the chinks in pebbles can ensure more economical decision of meliorative task with passing use of basic weight pumped out fresh and concerning fresh underground waters for irrigation and washings, and also for centralized economical drinking water supply having here and important meliorative meaning (at the expense of the termination winter water serving for this purpose on irrigating network). Marked debit in most cases is possible at downturn of a dynamic level on 10-15 m (specific debit from 35 up to 10 L/sec and more) and depth of chinks about 50-100 m.

Deposit of chinks of a considered type, in the volume number by a diameter up to 800-1200 mm, is provided already with available self-propelled machine tools high-speed rotor drilling with direct and return washing. The large diameters of drilling simplifying a task of creation of the powerful grave-sandy filter around stranger of a chink sharply reduce at the end specific cost of pumped out underground water.

The rather small productivity existing horizontal drain in cover small-ground is conditioned sometimes not only lowered filtered ability the last, but also small dip of drain is direct under a level of underground waters. In particular, it is caused also by that in already wetted and strongly becoming swollen small-ground practically was not presented possible to put in pawn deeper drainage.

At pumping out is superficial (0-1-2 m) deposit of underground waters from a single chink or their small group, when they do not cover completely file subject land-improvement, in an external contour already on small distance from a chink the depth up to a water mirror can be of less design norm of drainage. Here, alongside with outflow to a chink, earth waters will be spent and for total evaporation from a soil cover. Naturally, at the expense of such joint action, chink and the evaporations the general area drainage and radius of action are increased, but the area with design norm of drainage can make only small part from potentially possible (proceeding from volume pumping out and size of the drainage module). So, at joint work of five chinks the area of grounds with design norm of drainage from potentially possible can
topographed area. About 60% out of them are salinized to a different degree, including 20% of greatly salinized lands. The total area of salinized lands correlates with the areas, where the groundwater (mineralization is over 2 g/L) lies in the depth of 2 m. The area of greatly salinized lands correlates with that, where mineralization of groundwater is over 5 g/L.

On lands, irrigated for a long time the maximum level is observed almost everywhere in August-September, irrespective of their geomorphologic geological structure. Minimum level is observed in February-March. This course in level regime of groundwater is caused by the corresponding consumption regime of river waters and water supply for irrigation. It disguises the role of the rest factors, on which the level regime depends, including such a great one as the total evaporation from the ground surface in the hot season of the year.

But the considerable change in level regime in future may occur on the land massifs, where vertical drainage will be applied. As a result of pumping out on vast territories the level may be on the depth of not over 3–5 m, when its regime fluctuations have no ameliorative meaning.

Mineralization and chemical composition of subterranean and forceful waters on irrigated lands in Tajikistan are also subject to regime changes. According to year seasons the most marked changes in this respect are observed on greatly salinized lands. There in the hot season of the year the groundwater of the surface shallow grounds with sharply increased mineralization is spent on the total evaporation from the ground surface, thus increasing temporarily the salt store in the soil grounds of aeration zone and on the land surface. The waters with lesser mineralization come to their place from the bedding pebbles. By the next vegetation period the adverse effect takes place – salts dissolve in the groundwater due to precipitation.

Large-scale application of vertical drainage on salinized lands will cause the gradual freshening of groundwater in the surface shallow grounds. But in the upper horizon of bedding pebbles, through which primarily stored salts will be pumped out, the gradual increase in waters mineralization will be observed for a number of years until at least to a time where change of initial water storage takes place within the whole range of rocks, during water pumping. In consequence, a gradual decrease mineralization of pumped out water may be observed. Finally, after corresponding stabilization under new conditions, mineralization degree of groundwater will be defined by the difference between for the total evaporation from the ground surface and the total depth filtration water throw from the irrigation network into exploited water-carrying horizon.

Mineralization and chemical composition of forceful waters of the second, third and deeper horizons (100–150 m) under the influence of vertical drainage in the most upper one (the first) will not be subject to considerable changes. Water from these horizons, as the least subject to pollution, is worthwhile being used for centralized water supply.

The essential change in mineralization and chemical composition of groundwater should be expected on the developed virgin lands with thick surface shallow grounds. At the first stage of developing these lands the descending waters currents will wash the salts out of the upper layers and transmit them into deeper horizons. When at the next stage the level approaches the day surface, the groundwater may have already somewhat less mineralization than at the initial state. At this moment the artificial drainage must begin functioning, gradually throwing the water and salts out of irrigated lands. The drainage flowing may be up to 30–40% of the total water-intake into irrigation systems. Due to this correlation between water-intake and the
surface flow of drainage and waters, the groundwater, already suitable for irrigation, may gradually being formed in the zone of active influence of drainage.

Filtration coefficient of water-carrying pebbles changes from the tenth parts of meter up to many tens and more meters per day along the separate irrigation sites. According to data from the main part, on the main irrigation massifs the value of filtration coefficient varies from 10–20 up to 30–40 meters per day.

In the upper layer of the surface shallow grounds, which is 3–5 meters thick and functions more actively under horizontal drainage, the filtration coefficient in most cases is 0.1–0.5 m/d.

The considerable area, where the strong pebbly water-carrying horizons are spread, gives an opportunity to create almost unlimited regulation capacity there. The preliminary cutting off the level of underground waters by 5–10 m and more may ensure the regulation capacity, which is sufficient in most cases for using the water-carrying pebbly horizons as underground reservoirs to regulate seasonally and for many years the flowing of that part of surface waters, which is not used yet.

Water-carrying horizons in pebbles are characterized by the high ability to absorb water, great area spreading and considerable total capacity (power). They give an opportunity to develop the broad network of highly productive chinks of vertical drainage and centralized water supply. Their debit may vary from tens up to 100–200 l/s and higher and draining effect may reach many tens and hundreds ha.

In irrigation sites, supplied with water and requiring ameliorative improvement of salinized lands, chinks in pebbles may ensure more economical decision of ameliorative task. The above-mentioned debit is possible in most cases, when the dynamic level decreases by 10-15 m and the depth of chinks is approximately 50–100 m.

Large diameters of drilling, simplifying the task of creating the powerful gravel-sand filter around chink strainer, finally will reduce considerably the specific cost of pumped out underground water.

4 CONCLUSION

As a result of our experience in agricultural use of non regulated surface water flow the irrigated land uses more than 30% of the total water in take into irrigation system in our country.

Therefore, it is necessary, first of all, to regulate the water use. The filtration coefficient (Kₒ) is often used for calculation of horizontal drains. In many cases the filtration properties of watered soils are changed over the short distances horizontally and vertically from the thousandth parts of meter up to several meters per day. The capacity of water-carrying horizons reaches many tens and hundreds meters, and the flakiness of the last horizon impedes the vertical water exchange. It is almost impossible to give the filtration coefficient value with proper accuracy for these conditions with relatively limited number of initial parameters.

Usually only the initial mineralization of groundwater in the upper part of water-carrying horizon is taken as a principle in project studies, aimed to change the existing meliorative and hydrogeological situation. The dynamic process of groundwater mineralization and, as the main thing, the possibility of managing them is not taken into account. By this approach it is possible to cause the land salinization in the near future, having at first fresh water and applying non-washing irrigation regime.
Critical correlations between bed depth and mineralization of groundwater for project conditions should be defined in view of other factors. First of all, the project depth down to groundwater should be defined, which will define in its turn both the permissible degree of mineralization and necessary rate for prophylactic washing. Finally, the economical technical equipment for decreasing the level of groundwater should be taken into consideration, as it is limited for horizontal drainage.

Development of salinized lands with groundwater bedded in not deeply is usually carried out in complex with general washing and artificial drainage. Project washing water is defined usually by simple multiplication of total saline store, which is to be removed out of root stratum, to specific water consumption. This rate is sufficient only for regular water distribution over the area. If the water distribution over the area is not regular, the main water mass is filtered near the drains. As a result of it the main part of the land remains unwashed. In this case the potential of the permanent network, which is to support the level of groundwater at the depth of 1–2 m, and is enough to reach to the groundwater derived from the surface washing waters. This leads both to decreasing manifold the productivity of drains and using the regulating capacity of soils in aeration zone and the time factors.

Reference