# Current status and problems of the drainage system in Uzbekistan

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Summary

Agricultural productivity in Central Asia has increased with the development of irrigation. In some regions, continual agricultural land use without adequate maintenance of drainage systems, despite using abundant water in the fields, has led to an increase in groundwater levels and soil salinization rate. The salinization level can be changed by controlling the groundwater level. Important countermeasures practiced in Uzbekistan include lowering high groundwater levels through open drainage, subsurface drainage, and vertical drainage systems. Here, we report the current status and problems of these systems in the Syrdarya Region, Uzbekistan, which is afflicted with serious salinization issues as per field survey results and existing data. Our results clarify that the functioning of the drainage system should be monitored because (1) the bottoms of the open drainage are too undulated to allow smooth discharge, (2) some outlets of the subsurface drainage are under drainage water level or covered with soil, and (3) the current operation style of the vertical drainage is different from the conventional one. Thus, it is important to ascertain the effects of the discharge systems in Uzbekistan.

**Keywords**
Drainage system, Groundwater, Salinization, Subsurface drainage, Vertical drainage

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## 1. Introduction

Agricultural productivity in Central Asia has increased with the development of irrigation since the middle of the 20th century. In parallel, the government has dedicated efforts and resources to maintain irrigated land conditions. In some regions of Uzbekistan, continual use of farmlands has resulted in the rise of groundwater levels and salinization rate of the soil because large amounts of water are used in the fields without adequate maintenance of the drainage systems. The salinization level can be changed by controlling the groundwater level. A countermeasure practiced in this region is to lower high groundwater levels via three types of drainage systems: (1) open drainage, (2) subsurface drainage, and (3) vertical drainage.

Japan International Research Center for Agricultural Sciences (JIRCAS) has undertaken several researches on measures against salinization since 2008. A study of the drainage system has been conducted in Yangiobod Water Consumers' Association (WCA) and Axmedov WCA at Mirzaabad District and Bobur WCA at Oq-olitn District, Syrdarya Region, Uzbekistan (**Fig. 1**). The present study reveals the current status and problems of these three drainage systems in a region with serious salinization issues (Okuda et al., 2012).

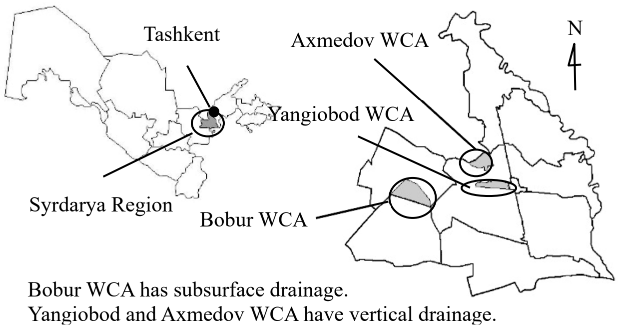
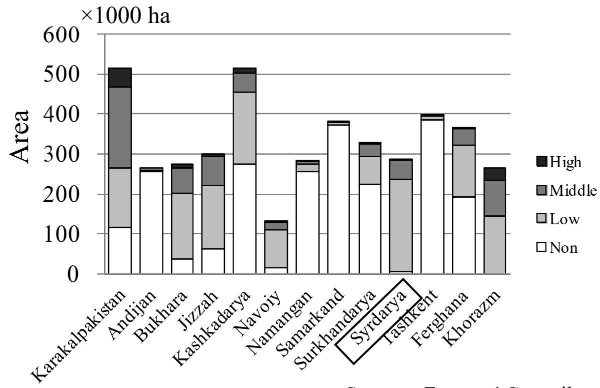



**Fig. 1** Location of the study area

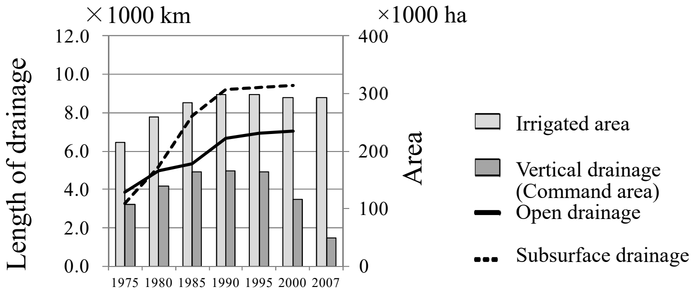
## 2. Study area

Central Asia has 10 million ha of irrigated land. Uzbekistan alone has 4.3 million ha of irrigated land, and almost half of this area is affected by salinization (Bucknall et al., 2003). Salinization is especially evident in Karakalpakistan, Bukhara, Jizzah, Kashkadarya, Navoiy, Surkhandarya, Syrdarya, Ferghana, and Khorazm (**Fig. 2**). The Syrdarya Region is located in an arid zone called as the "Golodnaya (Hungry) steppe." Here, precipitation is concentrated between the winter and spring seasons (average precipitation rate, 325 mm year$^{-1}$ in the past 10 years). The Syr-Darya river, the main resource for irrigation, flows along the east edge of this region. Approximately 300 thousand ha of land has irrigation and drainage systems in 2007 (**Fig. 3**), and almost all the irrigated land is salinized. Hydro-Geological Melioration Expedition (HGME) is in charge of executing measures against salinization, including monitoring of groundwater level, water quality, and soil salinity and recommending the necessary actions to the concerned organizations. The Department of Pump, Electricity and Communication is in charge of vertical drainage.




Sources: Farmers' Council

**Fig. 2** Region-wise area of salinization (2011)




Sources: Research Institute of Irrigation and Water Problem

**Fig. 3** Changes in the development of drainage system

## 3. Materials and methods

Data for this study were obtained via field surveys and interviews conducted between 2011 and 2013. Topographical survey, observation of drainage discharge, groundwater level, and electric conductivity (EC) were conducted to study the open and subsurface drainages. Salinity of water and soil sampled at the survey area was analyzed by the Institute of Irrigation and Water Problem (RIIWP) and Gulistan State University. To understand and analyze the current status of drainage systems, interviews for collecting the data/information were implemented with the assistance of RIIWP, Farmers' Council, HGME, and Department of Pumping, and Electricity and Communication in the study area.

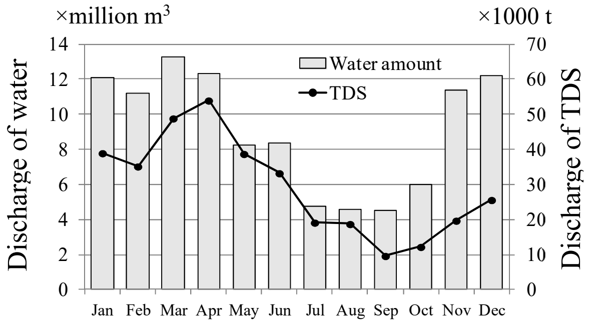
## 4. Current status and problems

### 4.1 Open drainage

The open drainage consists of a branch drainage (Inter-farm Collector) that connects WCAs, drainage canals (Intra-farm Collector) built between the farmlands in a WCA, and the other small drainage canals. The drainage system requires a drainage depth at which groundwater can flow out. In the survey area, depth of the collectors was approximately 2–4 m, with depths of small canals < 2 m. HGME undertakes executive responsibility for collectors and performs cleaning on the governmental budget distributed to

HGME. Small drainage canals near the border of fields with different water uses are constructed by famers or others. As per the data from RIIWP, length of the collectors increased with the increase in the area of irrigated land until 1990, after which this practice was not extended. According to the interviews, performance of the collectors has declined by sedimentation each year. Therefore, repair and renewal measures for the collectors are critical.

Observation of discharge and water salinity downstream of a collector in Bobur WCA showed effective salinity run-off in March and April. However, lesser salinity run-off was detected in October and December, despite an abundant discharge (**Fig. 4**). Flowing of the irrigation water into the collector is wastage of water. Results of a topographical survey indicated that the collector's bottom is at 2–3.5 m depth to the field surface. The width of the collectors, including both sides of the slopes, is 20–30 m. Collapses of slopes and thick growth of weeds contribute to sedimentation and stagnation of drainage water. This inadequate maintenance causes an increase in the drainage water level, because of which the groundwater is unable to flow out to the collector. It is also easily influenced by water use in the field surroundings.




Discharge of water includes estimated value.
Discharge of Total Dissolved Solid (TDS) is estimated by observed EC value.

**Fig. 4** Discharge and TDS in a collector

## 4.2 Subsurface drainage

In Bobur WCA, subsurface drainage pipes were installed at depths of 2.5–3.0 m, and the spaces between the pipes are approximately 210–250 m. There were four pipes in the survey field: three (Nos. 1, 2, 3) were near the research field and one (No. 4) was present 1 km to the north. The outlet of No. 1 was lost; that of No. 2, covered by soil; that of No. 3, observed under drainage water; and that of No. 4, exposed above the drainage water level (although that of No. 4 was supposed to be covered with slope soil eventually). In June 2012, the height of outlets 2 and 3 were 1.1 m and 0.3 m below the drainage water level, respectively. After removing the covering soil and water near the outlet, discharge quantity from each outlet was measured. Differences were noted among the discharges for Nos. 2, 3, and 4, with less than one-twelfth difference for Nos. 2–4 and one-third difference for Nos. 3 and 4 in July 2012 (**Fig. 5**); this gradually reduced to almost zero and then one-forth by August, respectively, while the discharge quantity for No. 4 remained unchanged. The outlet

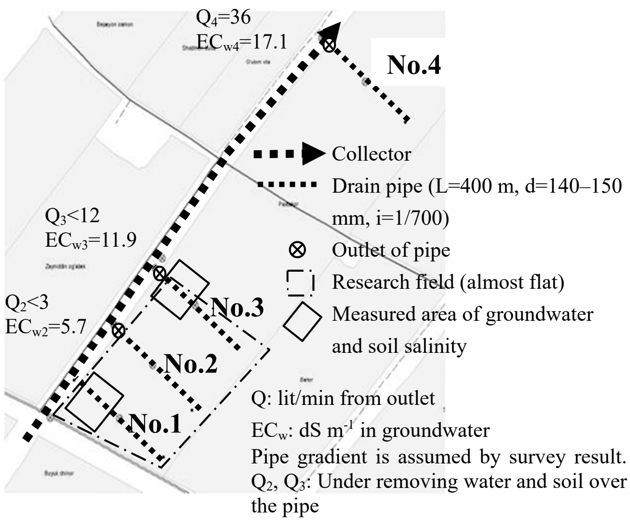
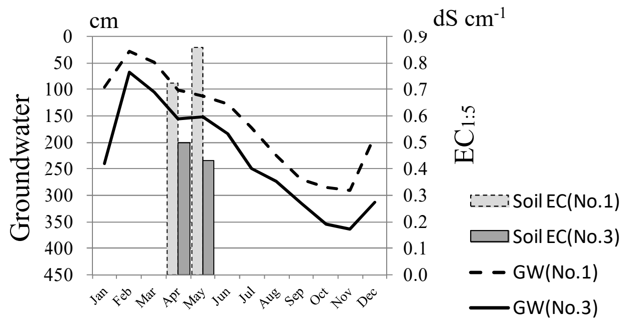



**Fig. 5** Discharge and EC (July, 2012)

condition has seriously affected groundwater discharge. In this study, the groundwater level was observed to be higher in February and March 2012, descending gradually until September and temporally maintaining its level during irrigation, followed by rising again from autumn onwards. The groundwater level near No. 3 was 0.5–1.7 m lower than that near No. 1. Soil salinity ($EC_{1:5}$) of No. 3 was approximately 30–50% lower than that of No. 1 in April and May 2012 (**Fig. 6**).




EC value shows average in a layer of 0–100 cm near collector.
Groundwater level (GW) shows average of near collector.

**Fig. 6** Groundwater and soil salinity ($EC_{1:5}$) (2012)

Outlet status affects groundwater level and soil salinity. The system has to keep the outlet above the drainage water level to expose it. The outlet needs to be protected to maintain its function.

### 4.3 Vertical drainage

The vertical drainage system controls groundwater via wells equipped with pumps. According to the query results of JIRCAS to RIIWP and the Department of Pump, Electricity and Communication in the study region, the first phase of development was set from the 1920s to the 1960s for research, testing, and establishment of the system; the second phase was set for intensive construction from the 1960s to 1995; and the last phase was set for operation 1995 onwards. The number of operations then reduced from 1995. In 2013, 450 vertical drainages were listed in the operation list of the department. Few overlapping areas were noted with subsurface drainage. According to the technicians of the department, the beneficial area of vertical drainage in this area would be approximately 100 ha. Therefore, a new vertical drainage is planned to be constructed within a distance of approximately 1 km from the existing one. The department pointed out a decline in the pumping potential due to degradation of the wells. RIIWP showed that pumps should operate continuously from December to February and during the season of high groundwater levels between March and August. However, currently, the operation pattern of vertical drainage is different between the investigations and results of data analysis on electric power consumption of the department. The annual groundwater level was also different between the investigation and field survey. According to the interviews, 80 wells were present in 11 out of 17 WCAs in the Mirzaabad District. Assuming that the influence radius is 500 m, the benefit circle does not overlap (**Fig. 7**). The number of operating wells was 49 (61%), 67 (84%), and 65 (81%) in 2011, 2012, and 2013, respectively, as per the data of electric power consumption. The reasons for no operation were explained by the department to be: under inspection and maintenance, theft of electric equipment, no request or necessity of operation near abandoned lands, and safekeeping in other places against theft. In these 3 years, the total consumption was small between the winter and spring seasons when the groundwater level is the highest. However, the total consumption was very high in summer. Thus, the difference in consumption between the summer and winter seasons was 3.5 times. Based on the request or direction by the HGME, the department takes a monthly decision of short-listing operational places and periods in accordance with the budget. The department also considers requests from farmers. The requests of operation generally increase in summer when the evaporation rate is high, causing increased salinization and shortage of irrigation water. In case of no salinity issue in the groundwater, the vertical drainage can be used for irrigation along with river water.

Currently, the performance of the vertical drainage system varies with method of operation. A new operation plan should be considered for optimizing the advantages of the system for maximum effect. In addition, the management approach should improve the functions of the system in line with the new data obtained.

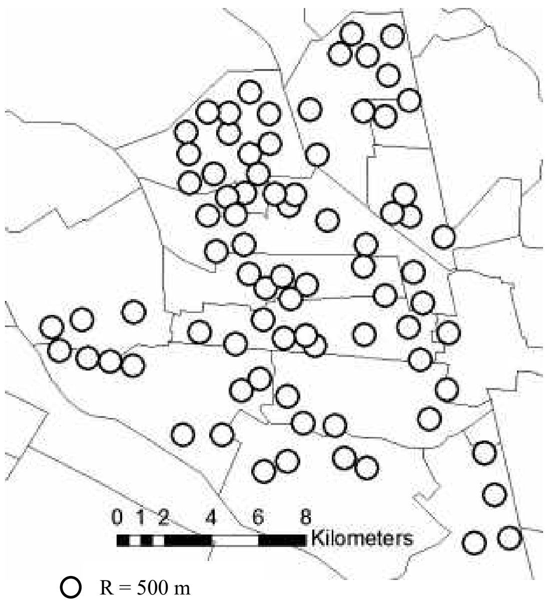



**Fig. 7** Location of vertical drain in Mirzaabad district

## 5. Conclusion

Some collectors in Uzbekistan face sedimentation and malfunctioning drainage-water flow, which contributes to increasing salinity in agricultural lands. Some outlets of subsurface drainages in collectors are placed below the drainage water level or are covered with soil, leading to a decline in groundwater discharge and hindrance to salinity correction in the soil. Cleaning of the collectors requires excavator machines, and farmers and WCAs cannot not use these machines because of budget limitation. Thus, government-supported cleaning projects can serve as appropriate measures. To achieve maximum benefits, surveys of collectors and outlets for subsurface drainages are necessary. The surveys should identify collectors for sedimentation removal. In areas with subsurface drainages, it is important to expose the outlet and ensure that it remains above the drainage level. In case of shallow collectors with repair difficulties, a possible suggestion is to decrease the salinity smoothly in the field by improving field drainage conditions, such as using shallow subsurface drainage. The current vertical drainage system has a varied number of wells and a different operation pattern than the conventional one. Studies on the effect of this current system are limited. It is therefore important to clarify the effect of the current operation system to design an efficient and economical operation system.

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*The above article was reprinted from “Journal of Arid Land Studies, Vol. 25, No. 3, pp. 81-84 (2015)” by courtesy of the Japanese Association for Arid Land Studies.