THE FRESHWATER SAVING

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Abstract

Nowadays everyone knows that only ≈2.5-3 percent of the world's water is fresh, where as the rest of it is saltwater, and is not suitable for consumption by humans or living things. Furthermore, identified that almost 70% of the freshwater is locked up as an ice and the rest is stored in groundwater, lakes, reservoirs and rivers [1]. So it is obvious that the amount of water required for human consumption that allows us to survive is highly limited.

Whether you have a lot of it or not enough, water is a necessity for human existence everywhere. However, the capacity in which we use water varies across nations.

Additionally, given data in graph 1 that the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold. Within the next fifty years expected, the world population will increase by another 40 to 50 %. This population growth – coupled with industrialization and urbanization – will result in an increasing demand for water and will have serious consequences on the environment.

As one of the alternative solve to this problem is water storage in reservoirs within snowmelt and rain water collection technology, which allows reducing the use of drinking water for irrigation. Today these technologies are widely used both in developed and in developing countries.

By reviewing worldwide existing technologies of storing water have been identified an optimal ones and in some schemes are improved. As the first one which is optimal for almost every high and moderate income people. This technology based on the use of surface reservoirs. When this is used as a reservoir tank still bottoms, secondary raw materials from the production of paints, which in turn reduces the cost of the project. This technology is more applicable for the regions with no winter and spring frosts. If there are frosts, surface reservoirs can be located in the building. Amount of water that may collect by using this technology is a maximum of $20m^3$. However, the reservoirs can be upgraded by addition of extra tanks connected to each other to maximize amount of water.

Another technology is the most inexpensive and accessible to all - improvised rainwater collection system. It involves collecting water from the roofs of the drainpipe, which are screwed or specially fitted bottles (from 2L to 5L on the lower tiers). This system can be used in addition to the

above. The uniqueness of this system is that it can easily be removed and moved. It is not replaceable, where there are often short rains and allows you to use the collected water for irrigation for example various seedlings in the garden or in the garden during the summer. Amount of water that may collect by using this technology is a maximum of 3-4m^3 at once from one roof surface area.

These technologies are exploited only in spring and summer period and are designed for private household or a small rural farm. In the winter time it is necessary to clean the system of all of the collected in the filters (if any) of dirt and, if necessary, the shells, pipes and preserve until the next maintenance period.

Keywords: MDG 1 (Millenium Development Goals), MDG 7, rain water harvesting, water collected technology, sustainability of water resources, tanks.

Introduction

According to the World Bank report, nearly 680,000 ha of irrigated land could not been used because of salinization, waterlogging, incomplete distribution systems, incorrect farming practices, limited fertilizer application, and, in some cases, lack of water [2]. For instance, in 1993, special irrigation system was required on the territory of more than 700,000 hectares of the total irrigated area (2,313 100 hectares), although it was designed only for 433,100 hectares. In addition, part of the agricultural drainage system is not working properly because of the shortcomings in design and construction. It is estimated that about 90 percent of the vertical drainage systems is not used because of the high cost of pumps [3].

Period of intensive agricultural activity is limited to one season, from March to October in the south, and from April to September in the north. Precipitations are insignificant, except for mountainous regions. According to RSE "Kazhydromet" data [4], the average annual rainfall is 250 mm, ranging from less than 100 mm at the Balkhash-Alakol region in the central-eastern area to 1600 mm in the mountains to the east and southeast. Approximately 70-85 % of annual precipitation falls during the winter, from October to April. Snow also often falls in November. Summer rains are frequently combined with severe thunderstorms, which sometimes lead to floods.

Continental climate is characterized by high evaporation, which together with low rainfall, leads to the need for irrigation in most parts of the country, and particularly in the south. Cooperation with the neighboring countries on the distribution of water is one of the priorities of foreign policy. The main reason is that about half of the surface waters (44.9 km^3) in the Republic of Kazakhstan comes from the territory of the neighboring states. Water from Syr Darya, Ili, Chu, Talas and Irtysh rivers is mainly used for irrigation. The most intensive use of the water is observed in Kyzylorda, South Kazakhstan and Almaty regions, where 90 % of the total irrigation water is used.

Use of water according to sectors and sources based on the data for the total area of 21,143 km^3 in 2010 (see Fig. 1) [2].

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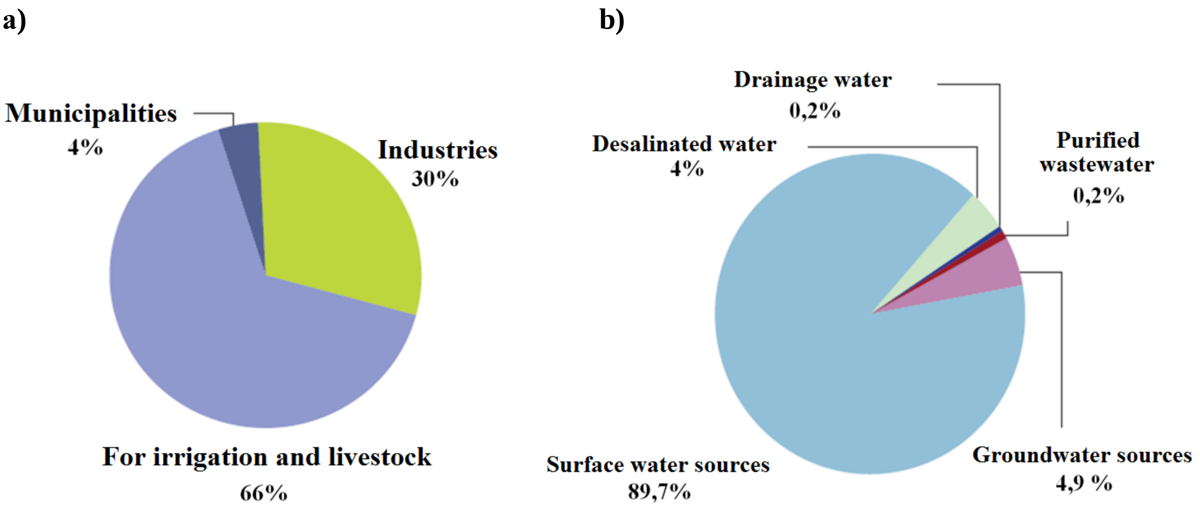

Figure 1 - Water use by sector (s) and source (b), based on the total area of 21 143 km^3 in 2010 [2]

It should be noted that in the above diagram (Fig. 1) there is no source of rain and melting water noted, which meets the standards if properly assembled and therefore is applicable for irrigation. This is due to the lack of necessary type of technology in the country. As a result the submitted project is devoted to the above mentioned issue.

The purpose of our project is to study existing technologies for rain and melting water collection, which can contribute to the rational use of drinking water, operating in different countries.

Objectives: 1) Review of existing technologies to collect rain and melting water;

2) Selection of the appropriate technology for its application in specific regions of Kazakhstan (Almaty and Akmola).

Climate overview. validity of setting the system.

In connection with the period of snowmelt and the maximum level of precipitations in Akmola and Almaty regions, as well as with the beginning of the massive use of water sources for irrigation all considered technologies are designed for use during the summer and spring periods.

In Akmola region annual precipitations decrease from north to south, with the maximum in June, and the minimum in February. Average annual precipitations count up to 265 mm [5]. Snow cover is held in an average of 150 days.

The average annual precipitations can vary from year to year. In 2013, precipitations above normal were registered in Zerendi, Burabay and Kokshetau (total precipitation level of 132-136 mm).

Within the normal range levels were registered in Akkol, Sandyktau, Bulandy, Ereimentau, Korgalzhyn, Yenbekshilder and Zharkainsk (within 51-118 mm, which is 80-120% out of normal rainfall). In other areas less than 60 mm or 80% of normal rainfall was noticed (see Fig. 2) [7].

Figure 2 – District division of Akmola region [7]

Table 1

Monthly and annual precipitations amount (mm) in Akmola region

Station	January	February	March	April	May	June	July	August	Septembe	October	Novembe	Decembe	Cold period Nov. - March	Warm period April - Oct.	Ann. Av.
Akkol (Alekseevka)	**18**	**12**	**16**	**24**	**36**	**44**	**62**	**51**	**28**	**34**	**28**	**21**	95	279	**374**
Astana	**19**	**14**	**18**	**20**	**31**	**41**	**52**	**41**	**26**	**27**	**19**	**18**	88	238	**326**
Atbasar	**19**	**14**	**17**	**19**	**31**	**39**	**44**	**35**	**25**	**25**	**23**	**19**	92	218	**310**
Berlik	**14**	**12**	**14**	**19**	**26**	**32**	**31**	**31**	**19**	**22**	**14**	**14**	68	180	**248**

Table 2

Dependence of the volume (V) of water collected from the rainfall in Akmola region

	Akkol (Alekseevka)	Astana	Atbasar	Berlik
Annual average	374	326	310	248
Estimated amount of collected water* (m^3)	**26**	**23**	**22**	**18**
Warm period (April –Oct.)	279	238	218	180
Estimated amount of collected water* (m^3)	**20**	**17**	**16**	**13**
* see section for technological aspects (approximate value of useful roof area in rural areas) ≈ 90				

The following connection was revealed: precipitations decrease from north to south. In the north the maximum level of precipitations is in July. In the south it is in June. The annual amount of precipitations also decreases from north to south. Akkol is the station with the highest amount of precipitations among the considered (374 mm per year). At the same time Berlik, located in the South, is the station with the minimum level of precipitations among the considered (248 mm).

Table 3

Dependence of the volume of rain and melting water collected in Akmola region (by districts)

Districts	**Annual average precipitation (mm)**	**Estimated amount of collected water* (m^3)**
Akkol	374	26
Astrakhan	318	22
Atbasar	310	22
Bulandy	317	23
Burabay	281	20
Yenbekshilder	347	24
Ereimentau	185	13
Zhaksynsk	360	26
Zharkainsk	350	25
Zerendi	397	29
Korgalzhyn	334	24
Tselinograd	232	16
Shortandy	321	23
***** see section for technological aspects (approximate value of useful roof sq in rural areas) ≈ 90 m^2		

According to the tables, the maximum amount of water that can be collected using special technologies equals up to 29 m^3.

In Almaty region the northern part is characterized by extreme continental climate, with relatively cold winter (-35 ^{0}C) and hot summer (+42 ^{0}C). Amount of precipitations is only 110 mm per year. In the foothill zone climate is milder with amount of precipitations nearly 500-600 mm. In mountains there is an altitudinal zoning; rainfall reaches 700-1000 mm per year. North and north-west almost do not have the surface runoff. The only river is Ili. In southern part, the river network is relatively dense. Most of the rivers (Talgar, Esik, Turgen, Chilik, Charyn, etc.) originate in the mountain areas and do not usually reach to the Ili River. Map of Almaty region is presented on Fig. 3.

Figure 3 – Map of the Almaty region [8]

Table 4

Monthly and average annual precipitations amount (mm) in the Almaty region

Station	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	Cold period Nov. - March	Warm period April - Oct.	Ann. Av.
Almaty	**30**	**32**	**66**	**100**	**98**	**61**	**38**	**27**	**28**	**51**	**51**	**34**	213	403	**616**
Bakanas (Balkhash	**13**	**10**	**17**	**24**	**25**	**19**	**16**	**10**	**7**	**19**	**18**	**17**	75	120	**195**

district)															
Kegen (Raimbek district)	**8**	**7**	**14**	**34**	**54**	**69**	**68**	**48**	**38**	**23**	**14**	**12**	55	334	**389**
Taldykorgan	**23**	**24**	**41**	**47**	**46**	**33**	**24**	**13**	**21**	**40**	**46**	**35**	169	224	**393**
BAL (Ile-Alatau National Park)	**22**	**28**	**56**	**100**	**143**	**131**	**102**	**73**	**46**	**45**	**43**	**30**	179	640	**819**
Ucharal															**400**

Table 4 represents annual precipitations at the stations of Almaty region, as well as precipitations in the winter and summer periods, long-term annual amount. At the Almaty station the maximum of annual precipitation falls is on April during the snow melting period (100 mm) and minimum amount is in January (30 mm). In general, nearly half of precipitations of warm period (from April to October) equals to the amount of precipitations of the cold season (from November to March). Annual precipitations amount is about 616 mm.

Bakanas region has significantly poor precipitations. Annual amount is 195 mm. Maximum precipitations are shifted to May (25 mm) and minimum are in September (7 mm). Observed at all considered stations, the greatest amount of precipitation falls on the warm period, although for the Bakanas region this value (120 mm) is even less than during the winter in Almaty. Other stations have been analyzed similarly. In general, we can say that central districts of the Almaty region have sufficient amount of precipitations. In the contrary, they are relatively low in Balkhash. Annual amount of precipitations in Raimbek region equals to that in Taldykorgan. However, only 55 mm falls during the cold period in Raimbek.

Thus significant annual amount of precipitations is compensated by precipitations of the warm period. It should be noted that there is a trend of increasing precipitation as the sea-level rise, for example Big Almaty Lake (BAL) station, where the annual amount of precipitation reaches 819 mm.

Table 5

Dependence of the volume (V) of water collected on precipitations amount in the Almaty region

	Almaty	Bakanas (Balkhash district)	Kegen (Raimbek district)	Taldykorgan	BAL (Ile-Alatau National Park)	Ucharal
Annual average	616	195	389	393	819	400
Estimated amount of collected water* (m^3)	**44**	**14**	**28**	**28**	**59**	**28**
Warm period (April – Oct.)	403	120	334	224	640	-
Estimated amount of collected water* (m^3)	**29**	**8**	**24**	**16**	**46**	**-**
***** section for technological aspects (approximate value of useful roof area in rural areas) ≈ 90 m^2						

To summarize, the largest amount of rainwater can be collected in the mountain and foothill regions (44-59 m^3), and the smallest, respectively, in arid areas, such as Balkhash region (8 m^3).

Review of existing rain and melting water collection technologies

Rain and melting water collection technologies can be used as additional source of water for the period of the urgent need - for irrigation for the farmlands as well as for domestic use in the private sector. All of this allows more efficient use of the drinking water. A simple scheme of water collection in special tanks through drain pipes underlies all of these technologies.

Currently these technologies undergo various improvements, aiming to obtain high quality clean and safe water. Economic feasibility of rain and melting water collection systems depends on: the quantity and quality of water available from other sources; household size and water demand per capita, as well as the budget. Efficiency primarily of technologies is dependent on precipitations amount.

One of the earliest countries, which started to use these technologies were the northern and north-western Asia, Australia and developing countries in Africa, where the shortage of water resources is extremely high. United Kingdom also has an example of rainwater application in the «Eden» project (collection of giant biomes, which all together form the largest greenhouse in the world). The composition of this greenhouse includes 3 biomes, showing the structure of the rainforest and Mediterranean areas, and vegetation of open countryside. Total surface of biomes is 39,540 m^2. For watering plants growing inside the biomes the rain water collection systems are installed. It uses pipes located on the entire roof. Water flowing from the biomes, is additionally used to increase humidity in the biomes themselves, as well as to drain the water in the rooms for the visitors. The water is accumulated in two underground tanks with a total volume of 240 m^3.

Originally rainwater was collected from roofs using plums and a variety of small capacities in a certain regions of Asia and in the plateau regions of China. Between 1970 and 1974, about 40,000 different forms of reservoirs were created for rainwater storing. Besides that the technology was used which allows accumulating water in artificially created ponds. On the bottom layer of it red clay was placed in order to reduce the drainage loss.

On the sides of it trees were planted to reduce evaporation [9]. Speaking in general all existing technologies of raincollecting water can be classified as listed below (see Fig. 4).

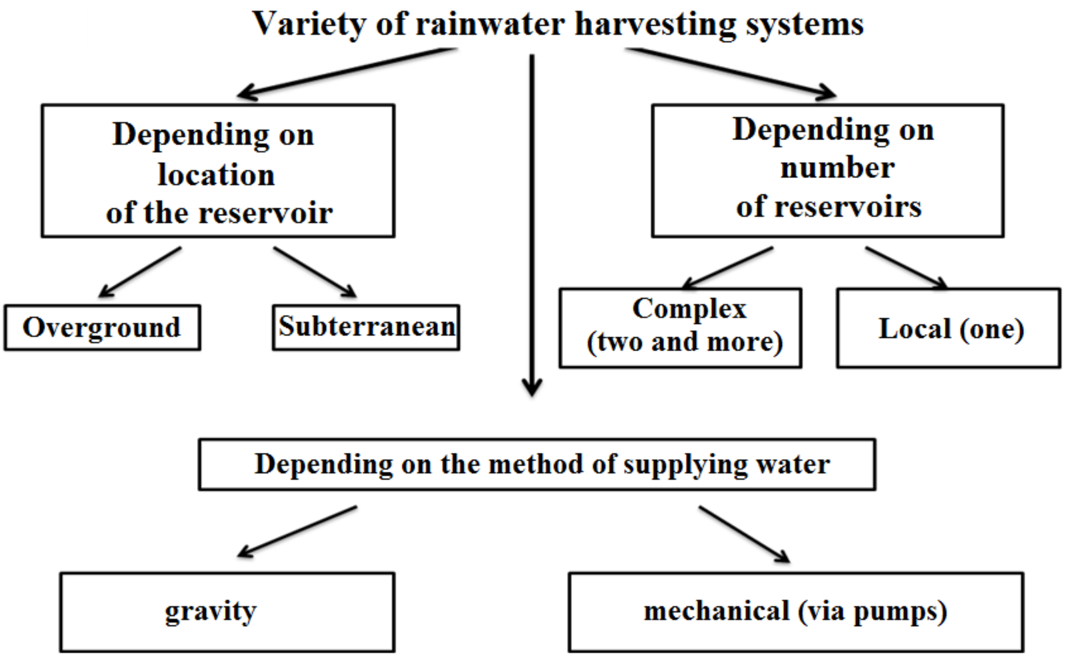

Figure 4 – Classification of systems for collecting rainwater.

Another great example of rainwater harvesting in rural areas is a technology used in the Philippines. Project on the use of rainwater was initiated in 1989 with the assistance of International Development Research Centre, Canada. For this project about 500 units of rainwater harvesting were built in Capiz province. Storage capacity ranged from 2 to 10 m^3. Overground tanks were made of reinforced ferrocement. Initially, this project was designed to develop the agricultural sector, namely for growing pigs [10]. Maintenance was usually limited to the annual cleaning of the tank and regular inspection of gutters and pipes.

Public initiative and the initiative of stakeholders play a key role in the implementation of such projects. The cost depends on the type of reservoir, as well as materials for the creation of such complete systems.

Rainwater can be collected not only from the roof. German experts developed a unique permeable paving for roads. Rainwater is collected directly from the sidewalk through the holes in the sides of the latter. Incidentally, this technology is integrated into one of our schemes in parallel with the collection of water from the roofs.

A system of "conversed umbrella" looks very elegant (see Fig. 5).

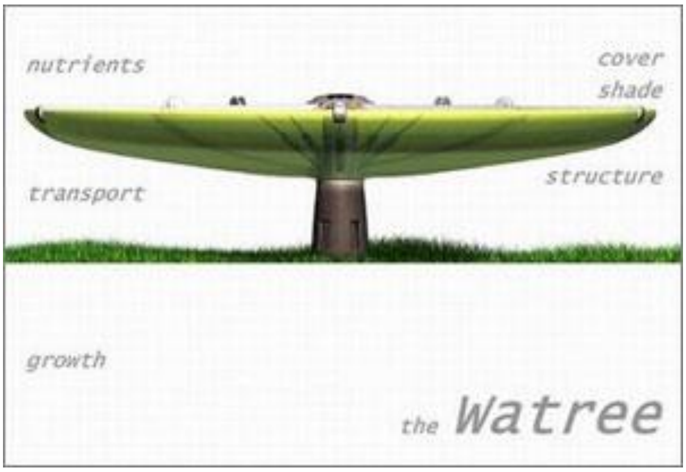

Figure 5 – A system of "conversed umbrella” for rainwater collecting

It is installed in parks and public places, but will fit for a large garden.

In any case, while conducting the analysis of the most appropriate method for collecting rain and melting water, you will need to answer a few questions, like:

1. Is this method (or circuit) for collecting water is the most suitable to local conditions?

2. Is there a high probability of its reproducibility?

Technological aspects

At the very beginning, before selecting the right technology for the region, it is necessary to spend some time on preparatory work. In particular, determine the size of the containers for collecting rainwater. And this can be done by knowing the surface, which is necessary to collect the water, as well as the average annual rainfall. The estimated volume of the water, which may be collected, can be calculated by the following formula:

V=(S*A*k)/1000 liters

where: V – volume of the water collected

S – total surface of the roof in m^2

A – annual amount of precipitations in mm

k –ratio of collecting water effectiveness, k=0.8

Critical is the material from which the surface for collecting water is made, as estimated volume of obtained rainwater depends on the type and design of the roof, the state of its surface. For instance roofs, which are not suitable, are covered with resin, gravel, asbestos. Such coverage might leave unwanted chemicals in the collected water.

First the perimeter of the roof is calculated, then its surface, excluding slopes and cornices. Usable surface is at least 80% of the total area. This parameter depends on the roof surface. From the roof rainwater gets to external channels, which lead it into the tank: downspouts and gutters, nozzles and "drain traps". Therefore, attention should be paid also to the materials from which they are made. Such gutters and pipes are considered unsuitable for collecting rainwater, which include lead. Via gutters water gets into the drain pipe, from where the channels depart into a water storage tank into storm sewers. However, due to the use of modern lightweight, safe materials for construction and repair such problems are rare.

Overground rainwater tanks can be placed in the basement (if you do not want to "spoil" the land surrounding the house, and there is some space in the basement). In the room, where the water storage tank is placed, the temperature should not go below 0 ^{0}C.

If you set up the over ground capacitance directly on site, it will save time and money since there will be no necessity for the excavation works. Ground containers might be of 750, 1100, 1500 or 2000 liters in volume and are chosen according to one’s needs and total amount of precipitations.

Underground tank is installed near one’s house. It is naturally cooled, thereby reducing the viability of microorganisms which are "living" in the water. Important condition for installing the underground tank is the low groundwater level. Size of excavation for the reservoir should be such that it would be possible to place pipes not less than 20 cm in diameter. Layer of soil above the established tank should not exceed 50 cm, thus the soil pressure on the tank is reduced to the optimum point. Underground tanks can have a capacity of 2,000 or 3,000 liters. Tank for storing rainwater should be tightly closed, have a special protective shield, preventing it from insects and microorganisms. Normal rainfall in the region, the construction of the roof and water needs should be considered in determining the model and volume of the reservoir for accumulation and storage of the rainwater. However, according to the experts, the capacity of the rainwater storage tank should not be too large, so that in a case of an accident or prolonged rainfall accumulated water flows freely mingled in the rain drains or plot.

One way to effectively clean rainwater is the use of filters. Typically two filters are used: primary, which is mounted directly to the pools, and secondary, which may be gross or subtle, depending on the further use of the collected rainwater. For irrigation purposes, it suffices to use only the primary filter. One of the quite common options is using sand, gravel and activated carbon fibers, which are layered at the entrance to the reservoir.

In circuits with underground tanks rather significant role is played by the entire pipeline system, so-called **storm sewer**. It is necessary to carry out a whole range of studies on site, estimate the loads and levels of rainfalls, select optimum equipment, prepare the clear project scenario and only after that start the installation.

Preliminary computation of storm sewer is almost as important as its skilled installation. Storm sewer is a system of pipes, chutes, inlets and additional elements, designed in order to collect and drain surface rainwater and melting water from the roofs of buildings, pavements and various platforms. Storm sewer systems are known since ancient times. For hundreds of years, they have proven their relevance and effectiveness. Prolonged deposition, torrential downpours and melting snow bring great harm to human activities and deliver significant inconvenience. It is capable of delay or entirely prevents many unpleasant consequences. <u>Proper installation of the storm sewer device allows you to</u>:

- protect roads, sidewalks, foundations and ripraps of buildings from premature failure;
- protect ground floors from dampness and reduce the likelihood of basement flooding;
- prevent the formation of puddles and frazils;
- prevent erosion of slopes and waterlogging of the soil;
- give the territory and facilities aesthetic appearance and save it for a long time.

<u>A scheme of a common storm sewer in some combination includes:</u>

- system of water drainage from the roof, consisting of gutters, funnels and pipes;
- wells and gullies for the point catchment;

- underground pipes leading from inlets to collectors, where eventually all storm water runoffs go;

- a system of linear drainage trays.

Such zones include sidewalks, paths, playgrounds, etc. The entire surface area is organized with a slight slope to the point (point drainage) or line (linear drainage) catchment.

The main principle of storm sewer - waste water from the roof and drainage area should be collected into a single stream and sent to the collector. This is achieved by combining the overall system of chutes and pipes that are tilted toward the spillway. Precipitations, flowing down the roof, fall within the perimeter gutters, and then into the branch pipes. From pipes water flows into the rain receiver - an essential element of a point drainage connected to collector by underground pipes.

Nearby ponds, ditches or specially arranged gulleys might serve as storm sewers in the countryside; where there are no backbone utilities arranged. Complete scheme of the storm sewer also includes such elements as sand traps (for the garbage collection), plugs (preventing backflow of water) and traps (do not let the smell come out of the sewage).

Methodology

The proposed technologies

1. Rainwater harvesting technology with using of surface tanks

This system works quite simply and effectively: the water is diverted into tank by downpipes and the excess of water falls into local channels or ditches. Reservoir or multiple reservoirs from which rainwater going to irrigation farmlands and orchards, can be installed in a utility room or along the perimeter of a buildings from the surface of which will collect rain water. The filter is installed in rain water feed system, which is right under the roof or directly on top of the tank. Once a month, it must be removed and cleaned of dirt. Another variant of filter can be installed removable mesh on the tank inlet pipe, whose function will be a delay of coarse particles. This system doesn’t require a pump for feeding water.

This system is more suitable for the Almaty region. This is due to the fact that in this area rainfall ranges from 100 to 1000 mm per year, and particularly no significant frost in the spring. And, accordingly, the approximate amount of collected water (V), given the overall useful roof area of 90 m^2 the average house in the countryside will reach:

V= (90 * 100 * 0.8)/1000 = 7.2 m^3 - for the lowland of the Almaty region (north);

V= (90 * 500 * 0.8)/1000 = 36m^3 – for the foothill areas of Almaty region. As the tanks to collect water may be used secondary raw materials such as drums of paint. (Fig. 6), Their volume is 1m^3.

Figure 6 – The proposed tank to collect water

Such tanks placed close to each other or through certain distance and have communication with each other as shown in Fig. 7: in case the first barrel is filled, the water gradually begins to fill the second barrel, and so on. Number of tanks is dependent on the amount of water that can be collected. This variant is more suitable for areas with little rainfall - the northern part of the Almaty region. Each barrel-tank has the tap at the base in order to be able to connect the hose and send it to the irrigated area. The same scheme can be installed not only near houses, but also in various buildings in the yard, which will allow to significantly increase the surface of water collection. If such tanks are installed behind the house, or in some places, where they can't be visible, we shouldn't have the problems with the aesthetic side.

Advantages: -relatively inexpensive cost, due to the lack the cost of installation ground tanks and pump buying,

- convenient to operate,

- ease of maintenance,

- mobility,

Disadvantages: -when a large number of precipitation is not suitable, because of necessity of extension the tanks chain,

- probability of water blooming,

- aesthetic side.

- covers the surface of the earth, which could be used for other purposes.

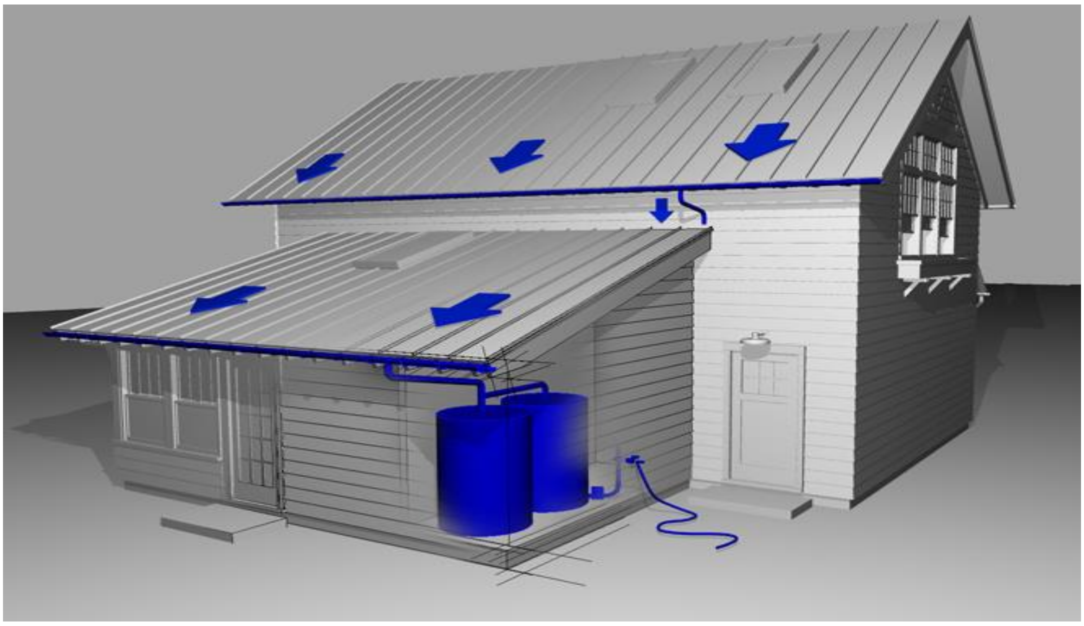

Figure 7 –Scheme of rainwater harvesting technology with using of surface tanks [11]

For areas where the rainfall is more than 100 mm would be logical to use polypropylene tank larger volume. Using such tanks for water avoid aesthetic problems, in case if there is no possibility to install a large number of barrels in a small area in attracting little attention way, but of course the cost of installation will be higher.

2. Rain and melt water collecting technology using underground tanks

This system is more complex than the previous one and allows you to use another alternative source of water - snow. The uniqueness of this system is that it allows to significantly increase the surface area from which water is collected. Besides we have the opportunity to receive water from yard surface further to classical collect water from the roofs. The latter technique is widely used in Germany, where the use of special paving of roads. Water flow through the paving and then by systems of covered ditches, placed on the side lines, are collected in underground storage tanks.

As seen in Fig. 8, the water from roof will be flow to gutter and by pipe system collected in tank. In order to prevent clogging and blocking pipe system from large debris, need to set gutter lattice. At the level of entry of pipe into the soil (at home foundation or directly into the ground) installed water filter, which in turn reduces the work associated with the service reservoir. Of course, water can be purify by precipitation, but this in turn will lead to gradual pollution of the tank, ultimately, it must be cleaned at least once a year. This fact imposes on the tank structure more nuances associated with extending the lid surface in order to people or some technique could safely pass through it. Another point is that the tank is underground, therefore clean the tank every year is not appropriate, so the best solution is to install a filter on the input.

Tank made of polypropylene (quite easy, reliable and stable), is placed at a depth of 0.5-1m below ground. As concerns collecting water from the yard, there is the main load will be impose to the collector (drainage sump), the surface of which is covered by a two-layer mesh with different diameter, acting as blocking various debris from placing it into the pipes. Collector, in turn, is located above in relation to the tank, its depth is up roughly 30-40 cm, diameter 0.5-1 m. The place for drainage sump can be in the lower part of the yard, so as to be able to put in the winter snow on top of it. Thus, with the advent of spring snow will melt and eventually drain into the tank. Very important here is that has reached store melt water, should not freeze, for this purpose the tank placed underground. But if the whether conditions very strong in spring time (-10^0-17^0 C or less) to pipe need to connect the heating system. Irrigation water is pumped by a pump. There's also a version of the overflow tank, this problem is solved by the drain system that leads into the sewer. This technology is very convenient, especially if the house or farm initially build with providing a rainwater harvesting system. Represented technology could be used both in Almaty and Akmola oblasts. Given that the Akmola region located in the northern part of Kazakhstan, which characterized sharply continental climate with significant freeze in spring, in this point it can be a serious problem for surface tanks. But if you use underground tanks such a problem shouldn't arise. Given the total usable area roof of house reach of 90 m^2 on the average, as well as the approximate surface area of households is 80m2, and the average annual rainfall in the Akmola region equal to 265mm, thus the volume of water collected (V) will reach 36 m^3.

V = (170 * 265 * 0.8) / 1000 = 36 m^3

Due to fluctuations in annual precipitation in different regions of the field, respectively, and the volume of the tanks will vary, so in Zerendisk, Burabay areas and in the vicinity of Kokshetau it will 18 $m.^3$

V = (170 * 133 * 0.8) / 1000 = 18 m^3

And in Akkol, Sandyktau, Bulandinsk, Ereimentau, Korgalzhyn, Yenbekshilder, Zharkainskom areas volume of the reservoir will be no more than 16 m3.

V = (170 * 118 * 0.8) / 1000 = 16 m3.

After the maintenance period must be cleaned: filters and the tank itself, along with the collector. And then lock system until next maintenance period.

Advantages: - encompasses two sources of water collection (snow and rain water),

-the possibility of collecting a large quantity of water,

- water does not bloom,

- tank does not take place on the surface.

Disadvantages:- the high cost of system

-the complexity of maintenance.

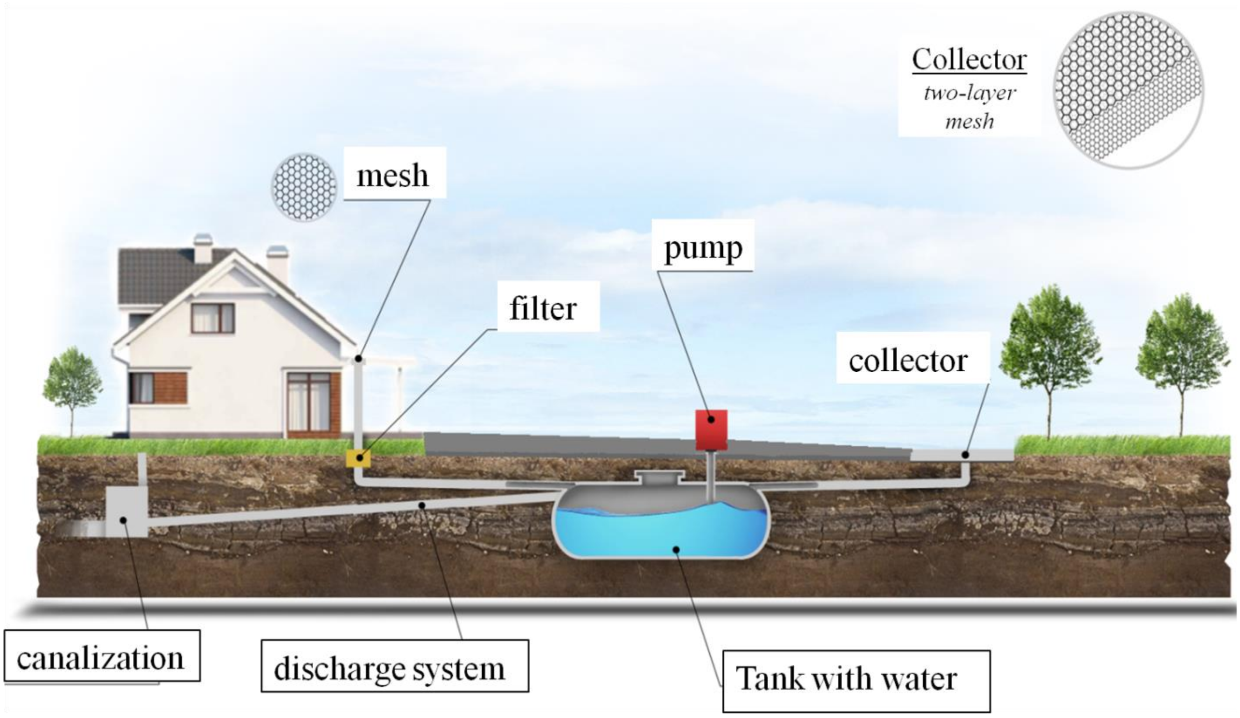

Figure 8 –Scheme of rain- and welt water harvesting system using underground tanks

3. Melt water collecting technology using water traps for water harvesting in artificial ponds

This technology encompasses the collection of melt water, which can be most effectively used for garden plots, located in the foothills, as well as a source of drainage irrigation water.

Water formed from melting snow, gradually begins to run down to ditches system, which are done in advance, as shown in Figure 9. Reaching the first stone wall, water fills the dam, further flows to the downward and ultimately to reached artificially created pond (check dam). Stone walls act like water traps. They in the form of a semicircle are 1.5-2 m in length, and 0.5-1m in height.

Despite of the fact that in mountain areas rainfall is sufficient, this technology is very important as a source of drainage irrigation, and is able to save quite a lot of water. So in the upland areas of rainfall in the Almaty region can reach 600-1000 mm. Consequently, the size of artificial pound depends on the amount of rainfall as well as the surface area of the water collection. The surface of the water collecting in turn depends on the number of dams (stone walls) and their distances from the distance relative to each other. On average, the surface will reach 120-150 m^2. Consequently, the potential volume of the collected water is 72 m^3

$V = (150 * 600 * 0.8) / 1000 = 72m^3$.

Zigzag structure location of dams on the ground allows to collect the melted water from a larger area. In this high cost will fall exactly on the deferent pipes to deliver water at to the place of requirements.

Akmola region occupies the western part of the Kazakh folded zone between mountains Ulitau in the south-west and Kokshetau in the north. Is the most suitable place to use this technology. In particular, it's south-western part, where the plains with some hills and eastern outskirts. So in the foothills Kokshetau average annual rainfall is 440 mm. Consequently, the potential volume of the collected water will be 42 m^3

$V = (120 * 440 * 0.8) / 1000 = 42m^3$

Despite of the apparent benefits in the amount of water that can be collected using this technology, this one of three presented basic schemes the least feasibl, in the light of the scale of work.

Advantages: - ease of maintenance,

- the possibility of collecting a large amount of water to 70 m3.

Disadvantages: - high cost,

- high level of water loss from the dam by evaporation,
- require significant area for check dam,
- the complexity in implementation.

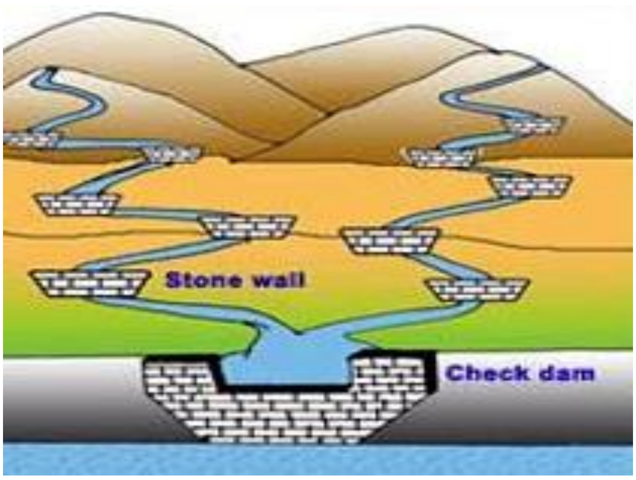

Figure 9 – Water collecting technology using water traps [12]

4. Handmade rain water harvesting system

With the development of natural resources saving technologies are becoming increasingly accessible manual assembly technology for rainwater harvesting. An example of this is a budget option - RainDrops system from designer Evan Gant.[13] Instead of bulky and expensive tanks rationally use the most common plastic bottles, which are using special adapters or simply by screwing, join to special drainpipe. The collected water can be used for watering the garden plots, small gardens and some of the vegetable garden. Bottle Size may vary from 1.5 to 5 liters of the lower tier (Fig. 10). The versatility of this system is that it can be easily moved to assemble and disassemble, and that is very important because of maintenance period can be much longer since the spring - by autumn. The system itself is designed for areas where rains are quite frequent, but intermittent. It can be applied both in Akmola and Almaty regions and also almost any regions in the period when there is no significant frost. Such facilities throughout the household may be several, whereby the amount of water collected can be increased if it allowed climatic characteristics of the region.

Advantages: - low cost,

- mobility,

- ease of maintenance,

Disadvantages:: - small water capacity.

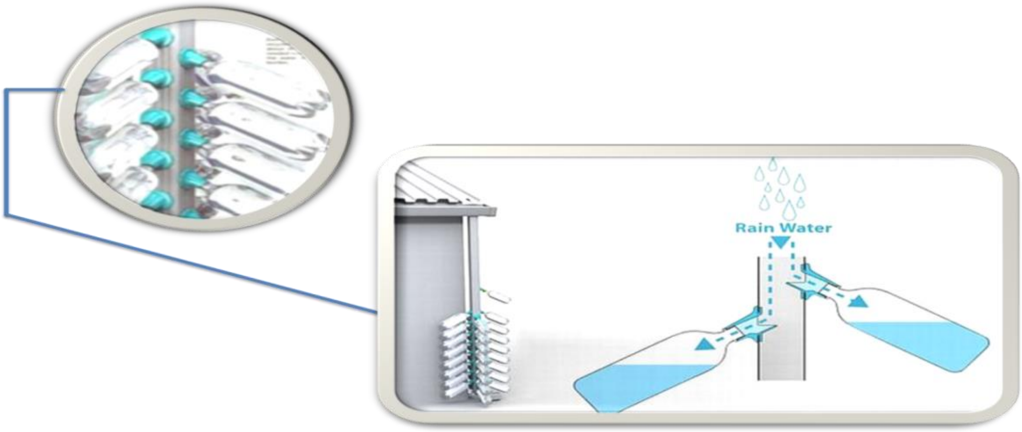

Figure 10 – Scheme of handmade rain water harvesting technology [14]

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Table 6 - The main components of the rainwater harvesting systems

System components	**Underground tanks**	**Aboveground tanks**	**Water traps**	**Plastic bottles**
Tank	Size of excavation for the tank should be such that it was possible to place the pipe thickness not less than 20 cm. layer of soil above the established tank should not exceed 50 cm, while the earth pressure on the tank will be reduced to the optimum point. Underground tanks can have a capacity of 2,000 or 3,000 liters. Tank for storing rainwater should be tightly closed, have a special protective shield that will make it impossible getting insects and microorganisms. Material is polyethylene.	Polyethylene tanks of 1,000 or 2,000 liters. Installed around the perimeter of the building or in the basement. Perhaps the use of recycled material - 1000 liter tanks out of paints. Depending on the amount of precipitation, the system applies different numbers of tanks interconnected by pipes.	Concrete walls, lined with blocks.	Plastic bottle under different liquids, the volume of 2-5 liters. Mounted directly into the drain pipe
The surface of the water collecting	Roof. Experts do not recommend collect water from the roof, which includes asbestos, lead or copper. Optimal from environmental point materials for water harvesting are natural materials, such as tile which does not contain artificial colors.		Поверхность земли в предгорных	Experts do not recommend collect water from the roof, which includes asbestos, lead

	Yard surface. It should be asphalted and have a minimum slope to ensure the spontaneous flow of water to the side of the collector.		районах.	or copper. Optimal from environmental point materials for water harvesting are natural materials, such as tile which does not contain artificial colors. Yard surface. It should be asphalted and have a minimum slope to ensure the spontaneous flow of water to the side of the collector.
Pipes	Plastic pipes with 20-30 cm. in diameter Length depends on the distance from the tank water placed.	Plastic pipes for connecting between the tanks with 10 cm in diameter and 40-50 cm in length.	Plastic pipes 20-30 cm in diameter. Length depends on the distance from the tank to water gathering places.	Downpipe with holes for installation of polyethylene bottles.

Filters	Protective shield on the roof for primary purification. Commonly known method of filtering is using sand, gravel and activated carbon fibers, which are arranged in layers at the entrance to the tank	Protective screen inlet tank made of metal net for primary purification.	Protective screen inlet tank made of metal net for primary purification.	Not required
Pumps	Performance with a depth of 1 meter not lees than 1000 l/h, the power - not less than 250 W, the AC voltage of 220 V. Overall pressure - of at least 4 atm.	Not required	Required if the pit is used as a source of irrigation in the drain. Or for the needs of neighboring homeowners.	Not required
Drainage sump (Collector)	Requires. Could made as from polypropylene, as cast iron manhole and concrete pit and also consist of a corrugated pipe and polypropylene bottom and lid.	Not required	Not required	Not required