P R O G R A M
OF IRRIGATION DEVELOPMENT IN THE REPUBLIC OF SERBIA
FOR THE PERIOD 2015-2020

INTRODUCTION

Pronounced unevenness of rainfall in a longer series of previous years causes immeasurable damage in agriculture devaluing exerted work by significant reduction in yield. After a series of drought years there were three flood years culminating in the preceding year whereupon a marked shortage of precipitation with all the characteristics of severe drought has occurred again in the current year. Agricultural production in our country, primarily in its northern part, is limited by the volume and distribution of water precipitation. Also all other activities which depend on orderliness of water regime which should be in accord with the requirements of economy and population are hindered in their normal development due to successive floods and droughts. Water balance of the Republic of Serbia shows that it is an arid region with distinct seasonal water balance deficits.

The current drought year imposes unavoidable need for irrigation to be included in one of the national priorities and long-term and concrete measures taken for the regulation of water usage, as well as complete regulation of protection against waters.

1. IRRIGATION NEEDS

1.1. Plants' Needs for Water

Lack of moisture in soil, which is in our climatic conditions particularly expressed in summer months, in July, August and in part in September, occurs not only in drought but also in moderately wet years.

Moisture deficit ranges in average from 100-250 mm, rarely even over 300 mm per annum.

Herein below is a comparative survey of the plants' seasonal needs for water and the state of rainfall in the same period of the current year for the areas of Backa and Banat:

No.	Crop	Max seasonal need for water April - September	Rainfall in the period April-September 2015	Rainfall deficit in mm (3 - 4)
1	2	3	4	5
1.	Maize	420	90	330
2.	Wheat	210	90	120
3.	Beet	510	90	420
4.	Sunflower	380	90	290
5.	Soybean	450	90	360
6.	Vegetables	450	90	360
7.	Alfalfa	540	90	450
8.	Fruits	450	90	360

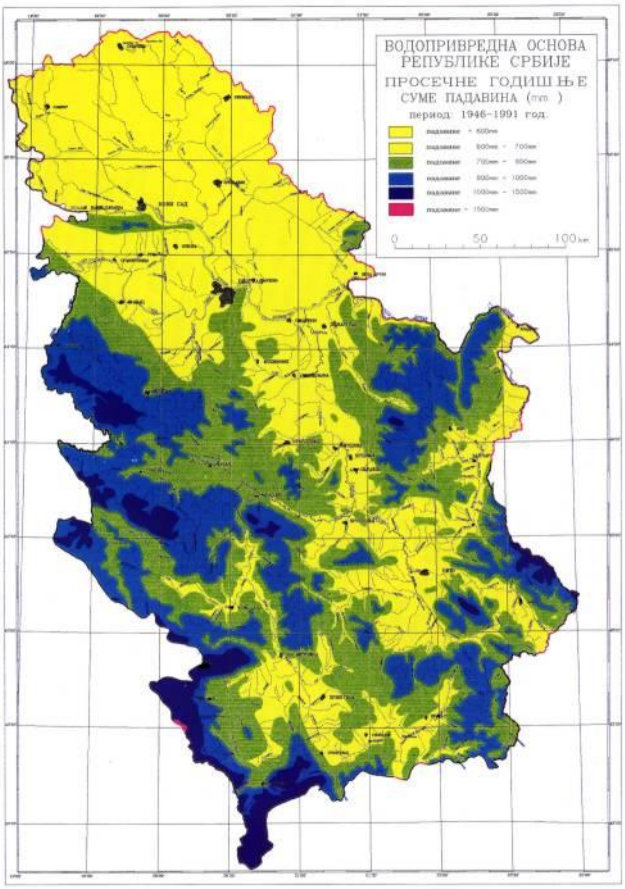
1.2. Rainfall and Irrigation Impact on Economic Growth

The creator of Hydro-system DTD, engineer Nikola Mirkov, has established through his analyses that out of 100 years, in the northern parts of the Republic, there are only 17 years with normal precipitations whereas 32 years are with rainfall surplus and even 51 with rainfall shortage.

Detailed review of precipitation distribution shows the tendency of changes in summer months. June is not the rainiest month any longer. Three connected decades without rainfall often occur in July and August. This situation ever more puts into question elementary survival of plant production in our conditions. In June, July and August, for intensive crop production it is indispensible to add 50 mm rain per square metre in each month. This means three irrigation rates of 50 mm each during summer. In our conditions it is unavoidable in 70% of the years in our climatic region. Implementation of such measures would most powerfully result in rapid increase of the scope of agricultural production and food industry products. That would lead to the increase of work intensive and productive mass employment. Abrupt increase of export from agricultural and food industry would reach 10 000 000 000 euro per year with significant net financial effect in foreign currency. No other measure of agrarian policy and implementation of known technologies can achieve such significant increase of economic growth, mass export and bring on so much needed positive demographic tendencies.

The current year is markedly droughty. Probability of the occurrence of such droughts for the period January-November 2015 was once in333 years. In the future, the incidence of excessive droughts will, unfortunately, be very frequent.

Questions can be heard in the public whether field crop production is possible in conditions where temperature is about 36 degrees Celsius. In the Mediterranean countries such as Greece and Italy, maize target yields of 15 t/ha to 18 t/ha are achieved despite high temperatures when irrigation is provided. Beside the said countries, countries such as Israel, Germany, Holland, China and UAE have large experience in irrigation. Resources that these countries avail with would enable a strategic partnership in irrigation projects in the Serbia area which are of significantly larger scope than the one anticipated by this initiative.



Internal distribution of precipitation within one year shown that on almost the entire territory of Serbia there is the most precipitation in the south-western part of the Republic and the least in northern, flatland parts.

Annual lack of precipitation uniformity is also expressed. Low water periods are very long and there is also a phenomenon of successive accumulation of drought years; from 1982 to 2015 there were only few years with precipitation above average and in all the rest years the precipitations were below average.

(Prevod naslova mape: WATER MANAGEMENT BASIS OF THE REPUBLIC OF SERBIA
AVERAGE ANNUAL PRECIPITATION AMOUNT (mm)
Period: 1946 – 1991)

Global climate changes due to greenhouse phenomenon point to the trend of shifting a warmer belt with smaller average annual precipitations towards north which also points to gradual ever greater need for water in these areas.

1.3. Irrigation Water Sources

Water for irrigation can be used directly from rivers or indirectly from storage reservoirs of regional hydro-systems.

Considering these droughts, for irrigation purposes can be used also groundwater (aquifer I) primarily from watercourses where this resource can be replenished more quickly when alluvial plains or backwaters created by dam construction are present depending on the discharge or level of water therein.

Channel network for drainage in lowland parts next to rivers is also used for irrigation purposes, preferably by means of their double purpose utilisation.

2. BASIC WATER MANAGEMENT PLANS

Basic documents for the preparation of a development plan are the Spatial Plan of the Republic of Serbia, Water Resources Management Basis of the Republic of Serbia, and Agriculture, Forestry and Water Management Development Strategy till 2021.

Having in view a great lag of Serbia in construction of irrigation systems, it has been envisaged for 30,000 ha per year to be covered by new systems. It is an ambitious undertaking thus, as per a scenario of a modest development, it is anticipated for 20,000 ha per annum to be materialised in the first years. In line with world practice, primary network would have to be the care of the state whereas the secondary network and equipment would be financed by users.

Such projects are capital intensive so that beside the construction of irrigation systems there is also the question of secured placing of goods onto international market. The new law on agricultural land provides possibility for this important resource to be included into concession projects and strategic partnership with countries availing with capital, technologies and large food markets.

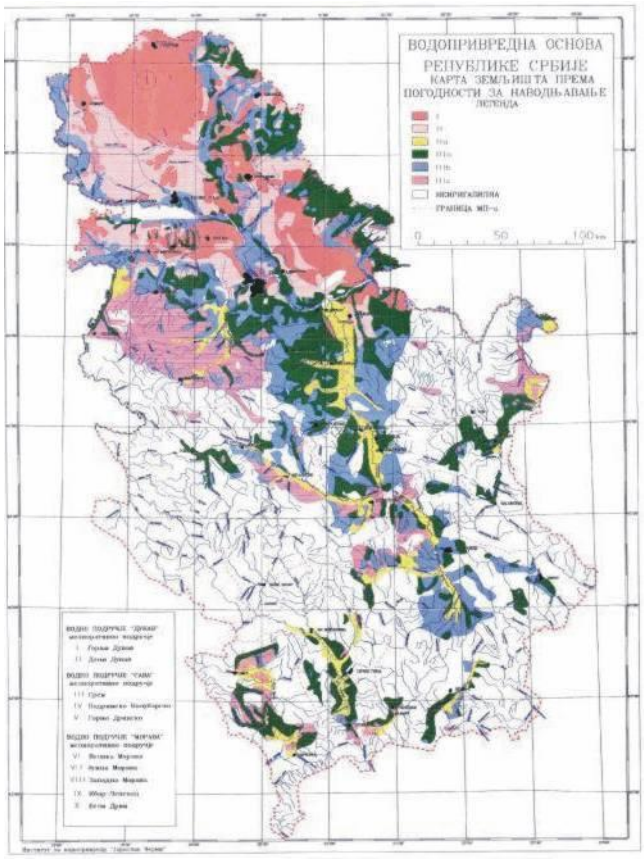
State-owned agricultural land in Serbia amounts to about 400 000 hectares which value is about 4 000 000 000 euro. A part of the said land can be included into strategic partnership with participants from the above mentioned countries and the enlargement of estates of local farmers who would be included into the said strategic partnerships.

Big investments within the field of irrigation cannot be economically cost-effective without mass production of pork in quantity of 5 000 000 pigs as a new production and 5 adequate slaughter-houses for processing these input materials into high value food products intended for export. It is also necessary to arrange production of two times 200 000 fattening bullocks and heifers on meadows and pastures which spread on 1 400 000 hectares in Serbia. The said bullocks and heifers would be processed in 2 slaughter-houses in hilly-mountainous region of Serbia and the entire production would be intended for export. Serbia can hardly increase the number of milking cows with respect to the previous period. Proposed concept of fatted bullocks and heifers production on grass can engage strategic investors for the export of such quality meat to foreign markets. Besides the production of bullocks and heifers on grassy areas it is necessary to prepare a master plan of lamb's meat intended for export. Spatial layout of mentioned processing capacities would follow the concept of polycentric development of Serbia in lowland and hilly-mountainous regions where in addition to these productions significant investments would be put into the production of fruits, vegetables, industrial crops, seeds, etc.

Total value of production in agriculture and food industry in Serbia would reach 16 000 000 000 euros of which 10 000 000 000 would be intended for export.

3. CONDITIONS FOR IRRIGATION DEVELOPMENT

3.1. Land



LAND MAP AS PER SUITABILITY FOR IRRIGATION

From the total available land fund in the Republic of Serbia of about 8.8 million hectares there are 5.9 million hectares of agricultural area of which 4.7 million hectares represent arable land, which 3.7 million hectares are plough land. Not all arable areas are suitable for irrigation but only 3.6 million hectares.

3.2. Water

3.2.1. Amount

In the Water Resources Management Basis are given optimum solutions for all interests viewed and recognized as drainage basin interests thus there is no risk of excessive use of water potentials at the expense of other water usage needs.

Large natural watercourses such as: the Danube, the Sava, Tisa, etc., as well as Hs DTD provide necessary quantities of water for all planned periods provided that regional hydro-systems be built and a certain number of storage reservoirs which must be built in parallel in order to meet required development needs.

3.2.2. Quality

Presently, water for the needs of irrigation can be used from almost all watercourses with exception of a smaller number of watercourses or parts thereof where water may be used with caution and permanent control.

4. PRESENT STATE OF IRRIGATION

4.1. Regional Hydro-Systems for Providing Irrigation Water

The issue of spatial and time distribution of water in the water-borne area of the Republic of Serbia has been studied to a great extent. Numerous studies, exploratory works and projuect documentation have been made. To begin with, water management area was studies in general; then, projects and designs were prepared and, at the end, regional multi-purpose Dunav-Tisa-Dunav system was built. Hs DTD gave a complex water management solution for a larger part of Backa and Banat; Hs "Nadela" for a good part of southern Banat; and, under construction are the phases I of regional hydro-systems: "Severna Backa *(Northern Backa)*". "Banat" and "Negotinska nizija (*Negotin Depression*). Also, general solutions have been made for water supply to Srem, Macva, Kolubara and Morava-Resava valleys, et al. There projects are being slowly constructed for several tens of years and mostly according to old, surpassed financing models. To that respect, revitalization of these projects is indispensable. BASIC FORM OF FINANCING THESE PROJECTS SHOULD BE FOUNDED ON THE INCLUSION OF A PART OF THE STATE-OWNED AGRICULTURAL LAND INTO STRATEGIC PROJECTS WHEREWITH FINANCIAL CAPITAL NECESSARY FOR INVESTMENT AND WORKING ASSETS WOULD BE ATTRACTED, AS WELL AS INCLUSION OF PRIVATE FARM ESTATES INTO THESE PROJECTS WHICH PRODUCTION WOULD BE INTENDED FOR EXPORT.

4.2. Watering Systems

According to the data from the Water Resources Management Basis of Serbia, the area of existing systems amounts to 120 000 ha as follows: 60,000 ha having water supply through Hs DTD; 55,000 ha having water supply from natural watercourses; and 5,000 ha from storage reservoirs. Unfortunately, nowadays, those numbers are much smaller and the assumption is that it is about 30,000 ha.

4.3. Double-Purpose Use of the Systems

On the territory of the Republic there are 22,00 km of channels built for drainage. Minimal number of such channels is presently used for double purpose, i.e. also for the needs irrigation. This means that, in fact, we do not use a large double-purpose water management infrastructure we avail with.

4.4. Use of Irrigation Systems Built So Far

It is estimates that presently it is intensively irrigated only about 30,000 ha.

Systems built significantly earlier for surface irrigation, in part by artificial rain, are practically out of use.

Watering system "Feketic"
Irrigation of second-crop maize, August 6, 2000

Systems built in 70s and 80s are in one part out of use due to being neglected and out-of-order and in the other part they are not used due to impossibility of bigger investments into production and lack of interest, as well as due to price disparity and uncertain collection of payment for finished products.

5. IRRIGATION DEVELOPMENT PROJECTION

Starting from available natural potentials (land and water) and work created potentials (Hs DTD and other regional hydro-systems, drainage systems, storage reservoirs and built watering systems which are not used); from possibilities to promptly commence repair of defective, reconstruction of dated and construction of new irrigation systems; from the needs to have commenced micro distribution of water intensified by means of adapting the existing drainage systems in order to enable a double-purpose use, as well as in order for spatial macro distribution of water to be continued through construction of regional systems, the following directions of development are suggested:

I Construction of regional hydro-systems which cover large areas for irrigation (Severna Backa hydro-system itself makes possible irrigation of almost 300,000 hectares of agricultural land from the system of micro storage reservoirs on Telek plateau) to be financed according to new models of strategic partnership which would include also a strong business cooperation with local farmers and construction of food industry plants.
Area of regional water management hydro-systems situated in the environment of state-owned agricultural land is very favourable for materialisation of strategic partnership. In such case, Serbia state would to a long-term period invest in the partnership its state-owned agricultural resource in a certain scope which would be used by strategic partner and a part thereof would also to a long-term period consign to the use of local farmers. Foreign investor would finance implementation of the whole project which would be fully oriented to foreign market.

II Reconstruction and repair of existing watering systems on 90,000 hectares in value of EUR 35 200 000:
Serbia disposes with about 3 000 000 hectares of agricultural land which can be irrigated. It means that our strategic orientation must be included in the master plan of irrigation in the Republic of Serbia which will cover areas larger than those planned for this purpose to date.

III IF WE WANT TO QQUICKLY INCREASE AREAS WHICH ARE IRRIGATED WE CAN DO IT ONLY WITH SMALL SYSTEMS (HOSE-REEL IRRIGATING MACHINES, IRRIGATION BOOMS AND OTHERS).

(In order to quickly increase surfaces under watering systems, HOSE-REEL IRRIGATORS are to be used, in particular small hose-reel irrigators for irrigation areas up to 10 ha. Purchase price of such a hose-reel irrigator is about EUR 6,500; therefore, for example, for 100,000 ha the sum of 65,000,000 euros should be provided. BUT, IN SUCH CASE, CONSTRUCTION SHOULD BE CONSIDERED OF A HOSE-REEL IRRIGATORS WITH A RENOWNED MANUFACTURER FROM GERMANY, AUSTRIA, ITALY...)

Total investment in hydro-engineering works, also including electric power supply to irrigation fields in 2015-2020 period amount to 717,200,000 euros.

Time schedule of works has been made with uniform annual investment, provided that in the first two years all defective and worn out watering systems on about 90,000 ha are to be repaired so that even in the third year it would be possible to implement irrigation on all 120,000 ha.

Construction of new watering systems would be gradually increased as in the first year would be built only those irrigations systems where already exists technical documentation which would only need o be innovated, and the pace of construction of new irrigation systems would grow with the preparation of new projects.

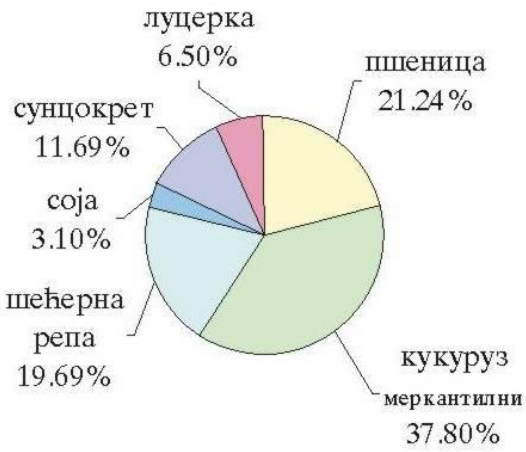
Construction of regional hydro-systems would have to be coordinated with the interest in construction of watering systems.

Operational program of irrigation development has been prepared provisionally and per regions based on elements from the Serbian Water Resources Management Basis. For each region information are given on existing irrigation systems and surfaces whereon construction of new irrigation systems is planned.

5.1. Production Structure Projection

Projection of the structure of production without irrigation (200,000 ha)

No.	Type of product	Yield in t/ha
1	2	3
1.	Wheat	3.8
2.	Maize, commercial	5.3
3.	Sugar beet	39.7
4.	Soybean	1.38
5.	Sunflower	1.76
6.	Alfalfa	7.35
	Livestock breeding	
7.	Cows, no. of heads	0.60
8.	Bullocks and heifers, no. of heads	0.40
9.	Lambs, no. of heads	0.025



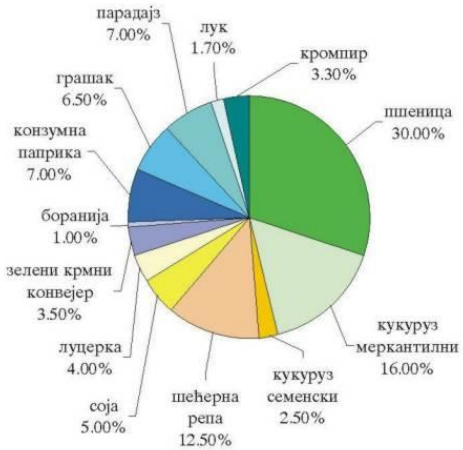
Structure of field crops in conditions without irrigation

When projecting the structure of production in conditions without irrigation, taken into account was the increase of agricultural production intensity and the upgrade of products assortment (e.g. vegetables), development of cattle and sheep breeding, and more favourable utilisation of plough fields in terms of second planting which is, in this case, planned on 32% area.

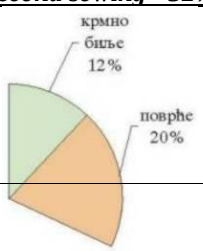
Projection of the structure of production in conditions with irrigation

No.	Type of product	Yield in t/ha
1	2	3
1.	Wheat	6.00
2.	Maize, commercial	12.00
3.	Maize, seed	3.50
4.	Sugar beet	65.00
5.	Soybean	3.50
6.	Alfalfa	13.00
7.	Green fodder	80.00
8.	Runner beans	9.00
9.	Consumption paprika	40.00
10.	Peas	7.00
11.	Tomato	45.00
12.	Onion	35.00
13.	Tomato	30.00
14.	Second crop forage plants	25.00
15.	Second crop vegetables	5.50
16.	Cows, t/head	0.60
17.	Bullocks and heifers, t/head	0.40
18.	Lambs, t/head	0.025

Regular sowing - 100%



Second sowing - 32%



5.2. Production and Economic Effects

Economic effects of irrigation for the suggested development variants are based on the calculation of the difference between the value of total production (crop farming + livestock breeding) and production costs according to standard price. Calculation result represents a financial gain which in conditions without irrigation for 200,000 ha amounts to 8,210,000 euros, and in conditions with irrigation 147,823,000 euros. The difference between economic effects of production with irrigation and without irrigation represents contribution of the irrigation to the increase of economic effects and amounts to 139,643,000 EUR/year.

For evaluation of the economic effectiveness of investment an economic flow has been developed for 200,000 ha as per standard methodology for this kind of investment.

Total revenue during the life of investment has been formed observing the construction time schedule so that full effects can be expected in the sixth year of the project life BUT, IN A YEAR SUCH AS THIS ONE, THE INVESTMENT IS PROFITABLE IMMEDIATELY.

Balance of the project value is included in Year 15 of the project life and represents computation of the not written-off value of fixed assets.

Evaluation of the economic effectiveness of these investments has been made on the basis of applicable methods pertaining to this field. Data from the economic flow of the project life have been used for calculation of the indices of effectiveness. The rate of 9% has been chosen as a competent discount rate.

PERIOD OF THE RETURN ON INVESTMENT HAS BEEN CALCULATED AS PER THE TIME SCHEDULE OF CAPITAL INVESTMENTS AND EXPRESSED NET INCOME DURING THE ECONOMIC FLOW AND IT IS IN THE 5TH YEAR OF THE FULL OPERATION OF THE SYSTEM. AS AVERAGE DEPRECIATION PERIOD IS 25 YEARS IT MAY BE STATED THAT THERE IS ECONOMIC AND SOCIAL JUSTIFIABILITY OF THIS INVESTMENT.

The above specified elements of economical quality do not include immeasurable material and social damages that drought generates. It is difficult to explain that large-scale investments made so far did not favourably solve damages caused by drought or damages from torrential or other floods.

5.3. Estimate of Required Capital Investments

а) Investments in Irrigation

Taking into account the suggested structure of production, as well as that the systems of various size and type of equipment will be built on both socially-owned and private agricultural estates, for the area of 200,000 ha planned for the next period the average amount of 3,200 EUR/ha has been calculated for the construction of new irrigation systems and the amount of 391 EUR/ha as funds for the reconstruction of outdated and repair of defective irrigation systems.

б) Investments into Livestock Breeding

Total funds required as per the projection of production amount to: EUR 127,965,500 for production of milk and calves, EUR 68,900,000 for bullocks and heifers fattening, and EUR 11,790,000 for lamb production which in total amounts to EUR 314,655,000.

ц) Investments into Machinery for Plant Production

In this case has been taken into account procurement of only specialised lines of machines: seeding-machines, planting-machines, sprinklers, combine harvesters, transport means, etc. These investments are necessary in order to mechanise production processes with respect to new crops and they amount to EUR 64,170,000.

д) Investment into Working Assets

In this case, required working assets determined as per specific methodology for each type of production have been accounted for as investments in the years of irrigation systems construction and as material costs of production in the years of system operation and they amount to the total of EUR 293,880,000.

Resultantly, total investments would amount to:

1. Hydro-engineering works ..... 717,200,000 €
2. Livestock breeding ..... 314,655,000 €
3. Machines and equipment in plant production ..... 64,170,000 €

TOTAL investments 1-3 ..... **1,096,025,000 €**

Investments into working assets ..... 293,880,000 €

TOTAL investments ..... **1,389,905,000 €**

5.5. Increase of Employment

IRRIGATION DEVELOPMENT WOULD CONTRIBUTE TO THE INCREASE OF EMPLOYMENT IN AGRICULTURE, FOOD INDUSTRY, WATER RESOURCES MANAGEMENT, ETC. ACCORDING TO A ROUGH PROJECTION OF THE INCREASE OF THE NUMBER OF EMPLOYEES IT RESULTS THAT THE TOTAL NUMBER OF EMPLOYEES IN THE SPECIFIED ACTIVITIES WOULD INCREASE BY 133,000 WORKERS IN THE PERIOD FROM 2015-2020.

6. TECHNICAL DOCUMENTATION

There are numerous projects and studies that have already been prepared for the repair of defective, reconstruction of worn out and construction of new systems and a certain number of those can be promptly innovated and forthwith used for execution of works. Other projects would be prepared gradually in accordance with determined work progress priorities.

7. FINANCING

It is certain that owners with their own funds, incentive funds of the government and bank credits must participate in financing of the investments. However, for the purpose of quicker effectuation of investments during construction of these systems it is necessary to pass to more contemporary forms of financing such as:

- joint ventures of business partners;
- granting concessions for particular irrigation systems;
- leasing; and
- crediting from abroad.

IT IS ALSO POSSIBLE TO HAVE A SPECIAL LAW PASSED ON FINANCING OF THE IRRIGATION DEVELOPMENT IF SUCH WOULD BE INCLUDED INTO ONE OF THE STATE PRIORITIES.

8. PARTICIPANTS AND PROGRAM IMPLEMENTATION METHOD

Irrigation development program for the period 2015-2020 has listed all participants in the performance of preliminary and preparatory activities from the domain of administration, finances, engineering, etc., including description of actual jobs which each of them should carry out. In addition thereto have been listed potential design/contracting companies and manufacturers of equipment and building materials. Project can be performed almost

entirely by domestic human resources, machinery and materials, except in the beginning years when it will be necessary to procure a part of machinery and equipment from abroad.

9. CONDITIONS FOR PROGRAM IMPLEMENTATION

Considering that water resources management does not have s separate ministry responsible thereof, in order to serve the needs of the program implementation it has been proposed for a Republic Directorate for Construction of Water Management Systems to be established. Such directorate should operatively be active in investment management within the area of water management system construction in cooperation with domestic and foreign expect teams. For the purpose of implementation of this program it is necessary to provide incentive government funds also to the hydro-engineering equipment producers based on specifically prepared programs aimed at launching of production.

Activities on the construction of regional hydro-systems will be performed as so far by Public Water Management Company "Srbijavode" and "Vojvodinavode" whereas operative management of activities on the repair and reconstruction of existing watering systems, as well as construction of new ones should be entrusted to the newly established REPUBLIC DIRECTORATE RESPONSIBLE FOR INVESTMENT MANAGEMENT IN CONSTRUCTION OF IRRIGATION SYSTEMS.

Belgrade, August 2015 Vladimir Bajic