A Decision Support System to finance irrigation investments: the Italian National Database of Investments for Irrigation and Environment (DANIA)

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Abstract. This paper presents the Italian National Database of Investment for Irrigation and Environment (DANIA), providing a multi-functional and interoperable tool for policy makers and water resource management actors. DANIA was born in collaboration with Italian Regions, in the frame of the Budget Law 2018 which provided the financing of irrigation investments. DANIA consists in a harmonized collection of planned and financed interventions for collective irrigation, aimed to irrigation or hydrogeological instability defense. The technical, financial, and environmental data are useful for programming, monitoring financial progress and evaluating policies' effectiveness. Standardized codes allow a semantic interoperability with other national database, particularly with SIGRIAN – the National Information System for Water Management in Agriculture. DANIA has been already applied to support programming and monitoring irrigation investments in Italy.

Keywords: information system; interoperability; multi-functionality; investment policy; water management; WFD.

1 Introduction

To support policy making processes in agricultural sector it is necessary to deal with a wide number of information from many sources, to include efficiency and sustainability principles. These data often are collected and codified autonomously, so that it becomes necessary the harmonization, in order to allow the connection between different sources.

The importance of databases for programming agricultural investments has been worked out at supranational scale; Daidone and Anríquez, (2011) presented an extended cross-country database for agricultural investment and capital, underling the need for homogeneous and multidisciplinary information to reach more targeted results. In Italy, the competence for water management and irrigation investments in agriculture is distributed among different actors and levels: Ministry of Agriculture (MiPAAF) and other Ministries (Environment, Infrastructure), River Basin District Authorities, Regions, and Local Irrigation Agencies (as actuators). Therefore,

especially by the time of water crises of 2003 and 2007, it was highlighted the need of coordination between these different administrations and Agencies of an intersectoral and national relevant planning of investments in the water sector, following the indications of the European Commission (EC, 2007). So, the National program of interventions in the water sector was launched, following the intervention strategy basically aimed at increasing water storage and irrigation efficiency, and promoting wastewater reuse. This strategy is still implemented with several regional, national and European financing sources for irrigation investments.

So, the existence of a unique database able to harmonize information from different institutions becomes of strategic importance. Several national databases (financial, environmental, agricultural data) are available and their interoperability, as pursued by INSPIRE directive (2007), allows an exponential increase of available tools for policy makers.

In order to support and match needings of all the involved parties, the Council for Agricultural Research and Economics - Research Centre for Agricultural Policies and Bioeconomy (CREA-PB), as scientific and technical support entity for MiPAAF, proposed a multi-functional and interoperable tool for the investment policies of agricultural sector, in coordination with environmental and sustainability principles.

This work aims to show the Italian National Database of investments in agriculture, as an example of a Decision Support System for agricultural water management, due to multi-functional and interoperable features.

2   Database data and structure

During 2018, CREA-PB started the creation of an investment database, in collaboration with Regions, collecting information useful for the selection of interventions to be funded by investment programs stated by Budget Law 2018 (GU 2017, L 205), with prevalent issues of irrigation (including multi-purpose reservoirs) or aimed to defend territory and agriculture from hydrogeological damages.

For reported projects, the level of planning, the compliance with Water Framework Directive (WFD) objectives and the intervention priority assigned by the Regions, has been requested at least.

However, these beginning information was not exhaustive for the wider issue dealing with the management of the several funding lines, and the correlated different type of investments. It became evident the necessity of a new structure, able to respond at the needing of all the funds in every phases of financing activities. Consequently, CREA-PB developed the National Database of Investments for Irrigation and Environment (DANIA). Stakeholders' feedbacks were considered in setting the structure. At first, the new relational database was implemented in Microsoft Access. Currently the online version of DANIA has been developed by CREA-PB (http://dania.crea.gov.it/), implemented on SQL server using Microsoft MVC technology. Web application will allow the Regions and the Irrigation Agencies (as implementing actors of the interventions, see fig. 1) to update online their information. The database will be accessible for consultation also to the Ministries and the River Basin District Authorities. CREA-PB is administrator user.

DANIA information is grouped into four sections (fig. 2), each of them is composed by one or more subsections.

Section I - project master data, groups general data of project, included the status (planned or funded).

Section II- intervention characterization, contains four subsections.

Subsection II-A contains the level of authorization acquired and the project progress status (feasibility, executive, …) to know if a project is ready to the realization.

Subsection II-B includes the intervention description with reference to type of intervention, prevailing purpose, type of works, WFD objectives and other information (fig. 2).

Subsection II-C includes the sensitive environment elements of intervention area, as hydrogeological and seismic hazards, vulnerability to desertification.

Subsection II-D deals with the strategic level of the intervention, namely the priorities assigned to the intervention at regional and River basin district level and consistency with the River Basin Management Plan (RBMP).

Section III - financial data, allows to keep track of the project amounts and funded amounts.

Section IV- monitoring data, contains geographical reference data (including SIGRIAN code of intervention area and WISE code of the involved water body) and dimensional data of intervention (extension of network, number of measurers, water volumes involved, area moving to higher efficiency, etc).
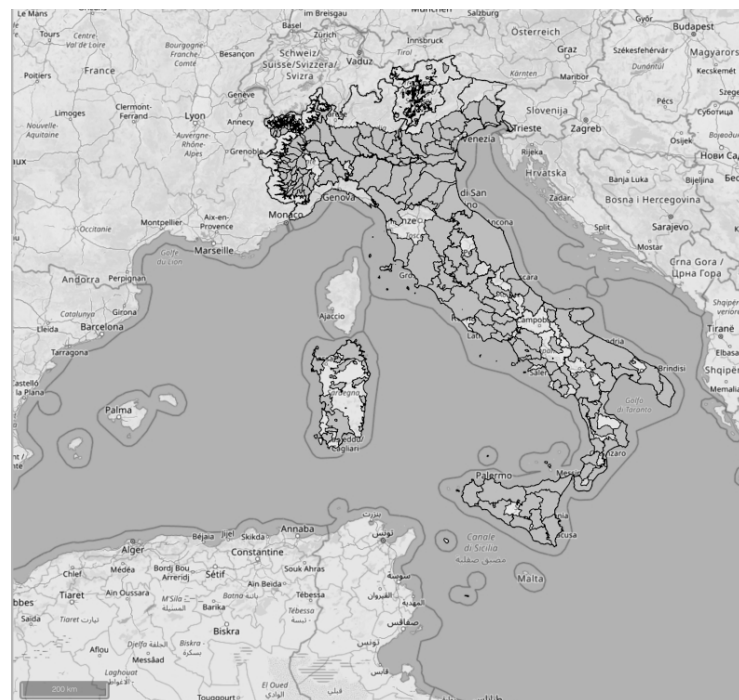

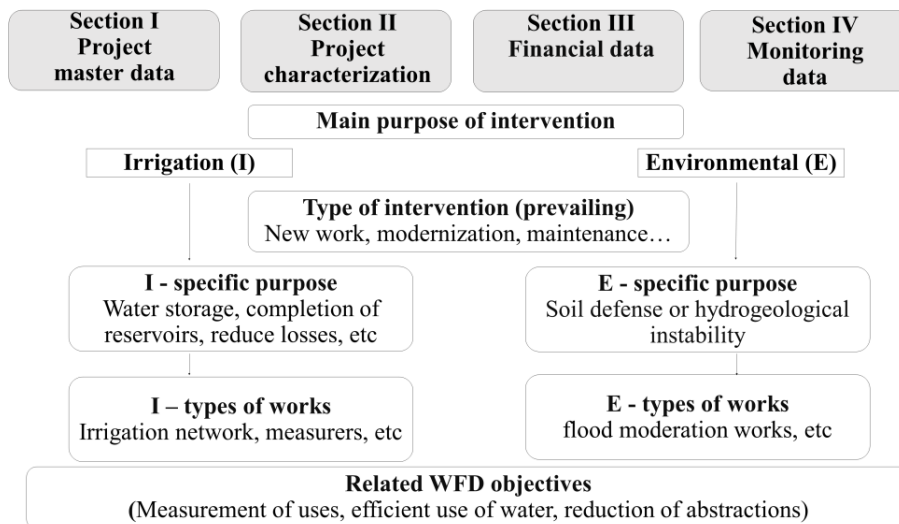**Fig. 1.** Irrigation agencies of Italy (source SIGRIAN).

Fig. 2. Basic conceptual scheme of characterization of intervention in DANIA.

3 Results and discussions: multi-functionality and interoperability features.

Currently, DANIA contains data related to about 1800 projects, referred to 224 irrigation agencies. Project amount resulted for about 12 € billion, of which about to 9 € billion is related to planned projects and the remaining related to recently funded projects. However, the data are continuously updated. Figure 3 schemed DANIA's numbers grouped for Regions at the end of 2019.

DANIA responds to the features of a multi-functional database since it is open at several public administrations involved in planning irrigation investments and territory defense at different geographical scales and institutional level. The first degree of multi-functionality stands in the possibility for each user type to employ DANIA for its specific purpose, starting from information on irrigation investments of its own competence. Moreover, DANIA makes available for national, regional and District Authorities, always up to date information useful for their own programming, without the necessity of periodic reconnaissance.

At national level, DANIA is a DSS to be use in different phases of the decision-making process for collective irrigation investments.

As first, in planning and programming phase the data, particularly those in Subsection II-B, allow to classify the interventions according to the implementation status, the purpose of the intervention, and the priority level. Selection according to the different funds aims may be based on this information and classification. Figure 4 shows some selection procedure based on DANIA data.

During the life of the project, several financing steps occur. Storing this information allows investigations on the progress of the single project but also the evaluation of spending capacity of funds allocated to Regions and actuators, in order to identify critical issues, or define the opportunities for future additional funding.

Finally, monitoring activities may support the assessment of investment policies' effectiveness. Information in the Section IV has been recently employed to calculate the indicators in the NRDP evaluation (table 1).

Several connections with other National database are included in DANIA's structure. Since the individual databases are designed to store specific dataset, many challenges arise when they interoperate with each other (Trinh et al., 2007). Through the unique project code (CUP), DANIA's projects can be track down within the Public Administration database of Public Works (BDAP), that is aimed at gathering all the information about the expenditure cycle of public works.

Another important connection is driven by Water Information System for Europe code (WISE) of the water body interested by the intervention. WISE is the European reporting information system relate to WFD implementation. The Italian node of WISE system is represented by the National Information System for Protection of the Italian waters, SINTAI (Cocchi and Alfò, 2013). WISE code allows the policy makers to know quality state of surface water and groundwater bodies involved in the projects. Furthermore, it is possible to link the investment realized and planning for each water bodies to the structural measures included in the Rural Basin Management Plans (RBMP). This allows to verify the interventions financed in application of current RBMP for agricultural sector and to know planned investment that could be included in the updating of RBMPs for the next WFD planning cycle (2021-2027).

Finally, DANIA collects identification keys from webgis SIGRIAN, related to Irrigation Agencies, districts and water schemes, allowing a first localization of the project. SIGRIAN, is the Italian national database of reference for all the infrastructural and management data of the national irrigation system, including monitoring of irrigation water volumes (Zucaro et al., 2019), useful for the fulfilment of obligations set by the ex-ante conditionality related to the EU Rural Development Policy (Zucaro et al., 2017a). The identification keys make DANIA and SIGRIAN coordinated and complementary database systems for the decision makers, even because, as set by MiPAAF, the compliance to obligations of metering and monitoring irrigation volumes are both precondition for financing investments and obligations for project funded. Furthermore, combining DANIA and SIGRIAN data can support the evaluation of water distribution efficiency for irrigation use. Indeed, comparing the water volumes abstracted and used, as implemented in SIGRIAN (Zucaro et al., 2019), it could be possible to identify any significant losses of the distribution network; this can be used as a selection key for projects stored in DANIA to find possible investments to be implemented in order to reduce water losses and improve the resilience of the irrigation system in the frame of climate change (Zucaro et. al., 2017b).
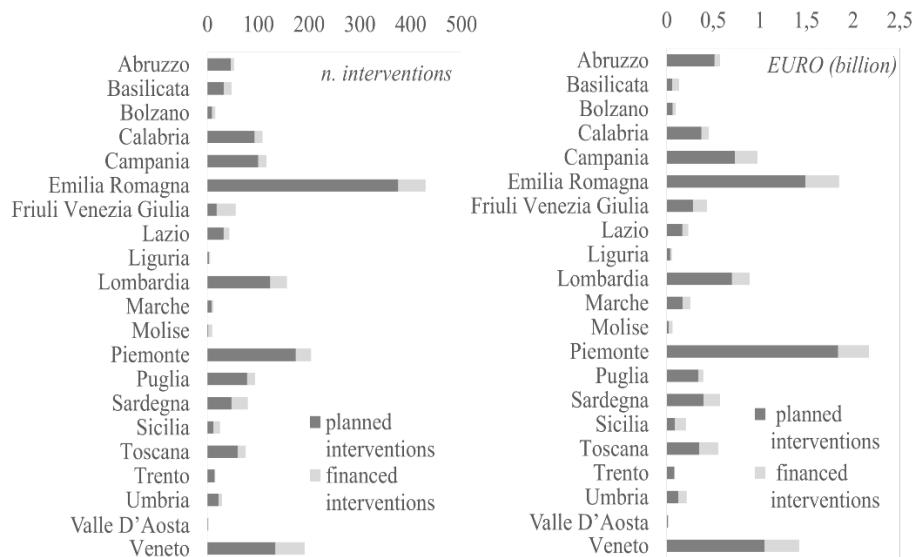
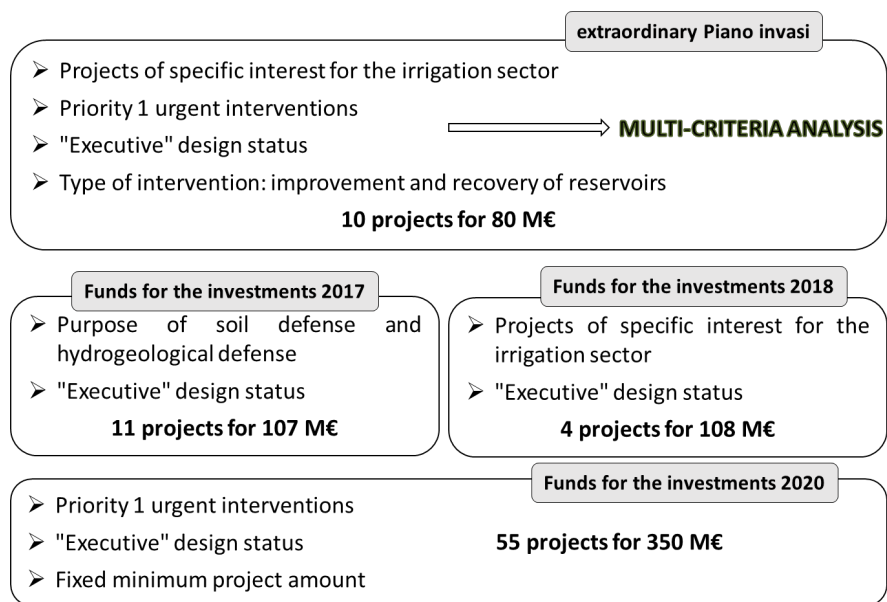**Fig. 3.** Planned and funded interventions grouped by Regions (source DANIA).

Fig. 4. DANIA Application in programming phase.

Table 1. Some indicators related to NRDP funded projects (source DANIA).

River basin district	Area with more efficient irrigation systems	Potential water saving through investments	Recovered volume of water storage	Realized volume of water storage
	(ha)	(m3)	(m3)	(m3)
Eastern Alps	156.532	24.623.493	36.500	39.200
Po river	187.486	41.017.752	412.500	291.700
Northern Appennines	10.128	4.820.570	-	-
Central Appennines	3.229	5.038.662	-	-
Southern Appennines	21.434	37.128.456	-	4.200
Sardinia	-	-	-	-
Siciliy	17.084	7.800.000	-	-
Italy	**395.893**	**120.428.933**	**449.000**	**335.100**

River basin district	New realization of network	Adaptation and modernization of network	Completed network	Total of network under intervention
	(km)	(km)	(km)	(km)
Eastern Alps	0	31.298	7.625	38.923
Po river	21	166	134	321
Northern Appennines	48	0	5	53
Central Appennines	0	84	0	84
Southern Appennines	0	2	1	3
Sardinia	-	-	-	-
Siciliy	0	7.719	0	7.719
Total Italy	**69**	**39.268**	**7.765**	**47.102**

4   Conclusion

DANIA contains a constantly update data on planned and financed interventions implemented by irrigation agencies, shared among all Italian actors of irrigation management from national to local level. Its applications confirmed the common conviction among the agricultural development economics researchers of the huge

importance of database for agricultural policy. By means of its multi-functionality and interoperability, DANIA promises to be a useful DSS for the Italian policies of the sector, also highlighting synergies and complementary of the various financed interventions and investments. Together with SIGRIAN, they are emerging as an essential element of the same information system for the investment policies aimed at reducing risks in agriculture, both in relation to water scarcity and hydrogeologic instability.

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