1. INTRODUCTION

The thesis reflects on architecture that control water management in rural landscape going to define an analytic framework to compare traditional and modern techniques. Today it seems necessary, after disasters caused by hydrogeological instability, to understand the role of architecture and his techniques in terms of recovery of river and canals bed and in particular all the devices that manage water network in the territory. The most of them are often in very bad conditions, abandoned or overcome by new technologies that are not able to contain disaster caused by heavy rain. Towards a recovery project and the definition of a framework of guidelines for requalification of river areas, it is important to build a knowledge about historical and traditional techniques of water control, diffused in territory and modern techniques, in particular those of agrarian reform of ‘50s, most of them have now fallen into
The construction of a historical memory on the topics of water control architecture aims to underline the capability of tradition to generate models of self-control and self-management, that belong to long-time forms. The Italian geographer Giuseppe Dematteis talks about cultural sustainability, in terms of ability to maintain and reproduce in time the principles that rule internal relationship of each single societies assuring their autonomy [1]. In this sense sustainability is intended as a process that rules dynamics of long-time, able to becoming self-sufficient.

Traditional lesson and recovery project are important topics in a research group active in DICAAR of University of Cagliari, coming from the experience of Atlas of recovery of historical villages of Sardinia. The attention towards weak context is important in order to keep in mind the possibility of revenge of margin areas in compare with urban or coastal areas. In villages we still find an extraordinary deposit of cultural sustainability forms and traditional models of self-control. The research is part of activities of PhD studies and it focuses on a portion of Sardinian territory, western Sardinia, that is an area crossed by the most important Sardinian river and subject of numerous transformation in modern period. The reclamation of Sassu pond, the building of Santa Chiara dam and artificial lake Omodeo has deeply modified territory leading water in areas characterized by strong water discontinuity. The importance of transformation has imposed an exchange between traditional and modern techniques generating new complexities. Understanding relationship between architecture and water devices is the base to define guide-lines and topics of project in this territories.

2. CULTURAL BACKGROUND

Within the work of Maurice Le Lannou, French geographer that visited Sardinia from 1931 to 1937, there is a portrait of an island still strictly linked to tradition. In Sardinia traditional forms and appropriation practices and uses have arrived until 20th century. During the last century important transformation has broken the strong link with traditional water management techniques, with the important reclamation work of Terralba plain and the wide ponds of Sassu and Santa Giusta. He underlines that Sardinia is the last region in Italy still to modernize, and the cause of this has to be searched in “special conditions” [2] of relationship between land and man. There has never been any question for the transformation of marshy plain, because the population was quite less despite the fact that the geography of territory made unsuitable the coastal plain of northern Campidano for agricultural disuse. The construction of a historical memory on the topics of water control architecture aims to underline the capability of tradition to generate models of self-control and self-management, that belong to long-time forms. The Italian geographer Giuseppe Dematteis talks about cultural sustainability, in terms of ability to maintain and reproduce in time the principles that rule internal relationship of each single societies assuring their autonomy [1]. In this sense sustainability is intended as a process that rules dynamics of long-time, able to becoming self-sufficient.

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practices. Before modernization work, water control was based on historical and traditional building techniques.

An interesting research about traditional techniques of water is that of Pietro Laureano who further explores the topic of self-generation and self-poiesis, dealing with recovery and redraw of fabrics and objects for water management in desert areas and southern Italy. Traditional knowledge consists, as Laureano says, in practices on an ecological and cultural environment, strongly recognized by population, result of an historical and stratified appropriation way. It is important the topic of multipurpose of traditional architecture and in particular the capacity to reuse their residuals in a productive way. The “reuse” has permitted an autogenous development without any external pulses [3]. On the one hand traditional techniques unify and integrate different functions and building typologies, on the other hand modern techniques aim to separate and specialize. According to Laureano, traditional technologies have to be read and interpreted as a cultural enrichment of the architect, that has not to mind to “miracle-solutions” [4] of modernity, but he has to set a method based on multipurpose possibilities, in order to follow the rules of necessity.

The atlas and manuals of the recovery of Sardinian historical centres deeply explore the theme of necessity as principle of traditional architecture and his capability to take root in the place. Manuals represent an extraordinary methodological example through an accurate work of mapping, typing and analysis on a regional scale of types of traditional architecture in Sardinia. Traditional techniques result an integrate part of a system of relationship, and it seems very difficult to isolate a single technology, not only linked to a definite environmental level, but linked to a clear and precise historical moment and a complex social construction nearer nature nomos. This form of “nature domestication” [5] of traditional techniques has been overcome by modernization era. Sardinian case offers interesting examples of modern work, in particular the theme of recovery of the imperfect modernization [6], according to Prof. Antonello Sanna, and the capability of certain objects in territory to supervise network control.

Reclamation works occupy a long period ranging from 20’s and 50’s and are the engine of agricultural modernization in the island. The director of Società Imprese idrauliche ed elettriche del Tirso, engineer Giulio Dolcetta, takes a guide role within this work, with the belief to use energy produced by dams to reclaim marshy areas of northern Campidano and the lower valley of the river. The foundation of SBS, Società Bonifiche Sarde, defines the beginning of executive phase of reclamation work with land expropriation and a complete redrawing of a portion of territory through a hydraulic adjustment
of torrential rivers. The work is concentrated on the Terralba plain with the river transfer of Rio Terralba and Rio Mogoro and a system of artificial lake, able to limit and control river floods during the winter and to make available for agriculture the countryside of Campidano Maggiore. From the basin of Ollastra two fundamental irrigation canals descend on the right and left side of the river. “The water for irrigation have to flow everywhere, without any stagnation” [7]. The rebirth of agriculture in Sardinia are implemented by the ETFAS reform in 50’s, through a work of land and agrarian transformation on expropriate lands, the foundation of new villages (such as the village of Santa Chiara, built for the workers of the dam), rural houses, factories for agricultural products transformations, electricity transmission lines and power stations linked to them, canals and aqueducts. ETFAS experience represented one of the last phase of intervention on rural landscape and on water control, defining new settlements, villages and agrarian fabrics.

3. METHODS

Sardinian territory offers a framework of different examples about transformation of water landscape. The long season of reclamation, engine of the island modernization, has deeply transformed Sardinian countryside through water distribution systems that have modified rural settlement
structure and relations. Canalization and river adjustment represent the act of the man to control water, defining a new bed, managing it from the wide field to small private garden, through a network of canalization for about ten kilometres long. Mutations take the sense of a transformation that territory have in its characters, the man can be a strong modifier of territory, but in this case he can suffer the effects and damages, like in the case of flooding, where the responsibility is that of incapacity to read natural modification of river. During the centuries water has been an important attractor for development of settlements, defining distances and proximities between villages. Prof. Antonello Sanna talks about “water obsession” that characterizes Sardinian villages, as a permanent factor of necessity and danger [8]. Through the reading of countryside structure, settlements and river fabric is possible to rebuild the rules of water control. In other terms it is still possible to read and to interpret urban forms and their distribution as a result of complex systems ruled by water, where absences and presences of resources and the way of management has been an important element to define the choice of a community for settling. The different alternatives have been different outcomes during the time, deeply influencing villages and countryside transformation, both in tradition and both in modernity, for example in reclaimed areas the agrarian adjustment is accompanied by new system of habitat with different densities. Chosen territory portion as case of study is characterized by the presence of stream character rivers, such as the rio Mannu, habitat of plain and hillside and an interesting relationship between hydrology and settlement. Toponyms are a valid item to verify, for example the terms Bangius is very recurring and not unusual, in order to indicate the presence of water or the prefix Pauli. In Tirso valley the toponyms Bennaxi and Gregori define flooding areas and the area for settlement. This defined bipartition between productive flooding countryside and its control and management, in other cases settlements incorrectly overcome the line of Gregori, exposing to dangerous phenomena, such as in the case of the flooding of Solarussa (OR) in November 2013. After the choice of territory to analyse, the research has studied the logics of relationship between water management devices and their modifications in urban and rural fabrics. This analysis is based on the reading of early ‘900 cadastral maps that convey an image of Sardinia before the agrarian reform and the reclamation works and where the relationship between settlement and water line follow the flooding line and settlements and river are often parallels. The choice of the site for dwelling has been dictated by the problem of collection and management of water, divided in a continuous choice between the distance from water that could risk terrible drought, and the problems of e acquedotti. L’esperienza ETFAS ha rappresentato una delle ultime fasi di intervento forte sul paesaggio rurale e sulle reti di controllo dell’acqua definendo nuovi sistemi inusitati, nuovi villaggi e trame agricole. 3. METODOLOGIA Il territorio della Sardegna, campo di indagine all’interno di questa ricerca, offre un quadro di esempi molto differenziato rispetto alle mutazioni dei paesaggi dell’acqua. La lunga stagione delle bonifiche, parte trascorsa della modernizzazione dell’isola ha trasformato profondamente le campagne sarde, attraverso dei sistemi di acqua portata che hanno influito profondamente sulle strutture degli insediamenti rurali. La canalizzazione e la ridisegnazione del fiume rappresenta l’atto dell’uomo di controllare l’acqua, definirne un nuovo corso, e gestirla dal grande al piccolo sotto un quotidiano controllo attraverso reti di canalizzazioni lunghe decine di chilometri. Le mutazioni assumono quindi il senso di una trasformazione che il territorio possiede nei suoi caratteri e in quanto l’acqua li rappresenta a pieno, l’uomo può farvi portare rispetto a questa istanza modificativa attraverso le sue manipolazioni o può anche subire gli effetti come nei casi delle alluvioni, dove spesso la responsabilità si deve all’incapacità di leggere le modificazioni naturali del corso d’acqua stesso. L’habitat e l’insediamento ha visto l’acqua come importante attrattore e la lettura delle sue relazioni ha definito le distanze e le prossimità dei villaggi. Antonello Sanna parla della “ossessione dell’acqua” che caratterizza i villaggi sardi, quale fattore permanente di necessità e rischio [8]. Risulta infatti possibile ricostruire attraverso la struttura dell’agro, il tessuto insediativo e le trame dell’acqua le regole di controllo dell’acqua. In altri termini è ancora possibile leggere e interpretare le forme degli insediamenti e la loro dislocazione come esito di un complesso sistema dettato dalle regole dell’acqua, in cui l’assenza e la presenza della risorsa idrica e la modalità di gestione è diventato un elemento decisivo per orientare le scelte delle comunità per insediarsi. La porzione del territorio scelta come caso studio si rivela emblematica per la presenza di ritì a carattere torrentizio, quale il rio Mannu, habitat di pianura e di mezzocosta e di mezzocasta e di mezzocosta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocasta e di mezzocast
diseases and flooding linked to the proximity. The economist Carlo Cattaneo talks about the extraordinary territorial inertia of Sardinia at the end of ‘800, but announcing a possibility of modification linked to a series of improvement that have to be made in the following years. The reclamation provides a significant boost to modification of territory and water control technologies. Aerial photos of ‘50s and ‘60s show a new fabric overlapped on traditional map characterized by a dense network of canals and an intensive agriculture. Traditional cultures and modern ones work together generating a new fabric of settlement. Traditional techniques of water management are based on the necessity to flow the water in excess, and to stock water in periods of absence, and can change from the place and incidence of the slope and divided in:

- distribution and drainage;
- conservation and storage;
- collection.

Building techniques of water regulations can be divided in two different categories, that derive by the incidence of slope and based on various problems that they have to solve. Water control has the primary necessity to rule the flow of the water mass in excess caused by sudden and intense rain, different for time and type, such as during the last flooding of Uras and Solarussa in 2013, or by the level of the water table or by the irrigation type.

In plain lands the hydraulic-agrarian arrangement has the function to keep away exceeding water in order to serve healthier the soil, in favour of the roots improvement and a better production. In the last cases of flooding, the problems are imputed to three factors, an extraordinary rain, that in Uras overcame 400 mm in 12 hours, despite of the annual medium about 600 mm, a human mistake, the dams placed in the river Tirso and Mogoro has not been opened, and the expansion of the villages in dangerous areas. The research aims to a redefinition of modern building techniques of water, defining a hierarchy between them:

- ditches at the scale of private garden;
- collector’s sewers referring to more units;
- artificial water basins.

Most important technologies in plain areas is the well, central node of public and private space. Wide, long interior courtyards of northern Campidano are characterized by the presence of well often on the limit of properties, becoming an important centrality in the semi-public space generated in the interior of an agrarian macro-courtyard, that is partitioned in different properties but collective in uses. The actual position of well and its uses transformed its role from the public scale to semi-public and private use. The area of Oristano storiche dai catastali di impianto degli inizi del Novecento che restituiscono un’immagine dell’inselemento rurale della Sardegna prima della riforma agricola e delle opere di bonifica e in cui il rapporto tra i centri e la linea dell’acqua segue la linea delle esondazioni tanto che la trama insediativa e il disegno fluviale corrono spesso paralleli. La scelta del sito di inselemento è stata fortemente dettata da rapporto tra captare e di irreggimentare l’acqua, diviso tra l’allontanarsi dall’acqua rischiando terribili scaglioni e, dall’altra parte l’avvicinamento al corso d’acqua rischioso a causa delle malarie nelle paludi o dei periodici allagamenti dovuti alla discontinuità dei rii. Carlo Cattaneo parlava alla fine dell’Ottocento dell’inzerzia territoriale della Sardegna, riferendosi però a una inezia che di lì a poco si sarebbe modificata in breve tempo. Le bonifiche immutano una forte modificazione nel territorio e nelle tecnologie di controllo dell’acqua. Le foto aeree degli anni ’50 e ancora di più quelle degli anni ’60 raccontano invece di una nuova maglia sovraposta a quella tradizionale caratterizzata da una fina rete di canali di supporto a una agricoltura semi intensiva. La messa a sistema delle culture tradizionali e delle culture moderne genera una trama insediativa nuova con cui oggi è necessario confrontarsi. Le culture tradizionali di controllo dell’acqua si fondano sulla necessità di far defluire l’acqua in eccesso e di conservare l’acqua in periodi di penuria e si possono dividere in tre tecniche fondamentali che variano profondamente in base al luogo e a seconda dell’incidenza del decilio.

Le tecniche tradizionali possono in tal modo essere divise:

- tecniche di diversione e scolo;
- tecniche di conservazione e accumulo;
- tecniche di captazione e drenaggio.

Le tecniche costruttive di regimazione delle acque possono essere suddivise in due categorie che derivano dall’incidenza del decilio e si basano sui diversi tipi di problemi a cui devono rispondere. Il controllo dell’acqua ha come necessità primaria quella di regolare il deflusso della massa idrica eccezente causato in particolare da picchi di pioggia, differenti per entità e periodo, un esempio sono le recenti alluvioni di Uras e Solarussa del 2013 che hanno causato un’assestamento dei rii. La sistemazione ideale-agraria ha sostanzialmente la funzione di allontanare le acque in eccesso in modo da rendere sani i terreni, favorire l’approfondimento radicale ed accrescerne così la produzione. Nel caso citato in precedenza delle alluvioni citate in precedenza, il problema si deve a tre fattori, la straordinaria precipitazione, che ha raggiunto picchi a Uras di 400 mm in una giornata, rispetto a medie annuali di 600 mm, alla mancata apertura delle dighe a valle posta a valle del fiume Tirso da una parte e del rio Mogoro dall’altra e dalla costruzione in aree rischiose, un tempo attraversate da corsi d’acqua o dal suo naturale alveo di esondazione. La ricerca mira alla definizione del patrimonio dei canali in luogo di esondazione. La ricerca mira alla definizione del patrimonio dei canali in luogo di esondazione.
represents a series of extraordinary examples of traditional wells and drinking trough for the animals, often in the merge areas of villages. Water takes a role of catalyst both in the community of village, both in the public space, both in the internal courtyards. Prof. Pietro Laureano, according to historical techniques of water collection, talks about a system of small wells already active in Phoenician-Punic periods, in particular on the slope of tuff rock hills, because of the technical ease of the excavation.

Traditional slope management techniques in the countryside are based on the logics of slow flowing of water in the slope working with a system of architecture able to selection water to pass.

The arrangement aims to reduce mass and speed of water that flows on the surface in order to favour a deep percolation and get longer the time of flowing. The agrarian-hydraulic arrangement of cultivated soils takes protective and economic function, defence from the aggressive role of water, limiting the erosive process, and economy, because it assures a better work of the roots and the use of resources. It is interesting the role of architecture in slope management, with different forms depending on the time of flowing and drainage. The same villages follow the rules of building in the slope, through a mixed system of distribution and collection.

Through the study of cadastral maps and reliefs in situ, it has been possible to identify interesting measures of water control in traditional villages: a system
of flowing-way, “sos guturreddos”, less than a meter wide, that work like urban ditches for flowing water in the slope. This narrow canal is characterized by an important constructive cure, with walls, pavement at the soil, in a way that it could be completely waterproof. The flowing way are typical of hillside villages. In the case studio area, the most interesting flowing way are in the villages of Santu Lussurgiu, Cuglieri and Bonarcado, hillside villages of mountains Monti Ferru, near the river rio Mannu, characterized by a compact and dense urban fabric, where the flowing way control the water flow on the slope.

4. EXPECTED RESULTS

The research shows that the results are still in progress, at the second year of PhD, so there are less touchable results, rather than observations and important deepening on knowledge framework. The aim is to elaborate a taxonomic framework on water technologies, understanding the differences between traditional and modern techniques and their use in plains end slopes. Through this item it is possible to have a knowledge framework to define an approach to recovery project of water network today in abandon. The point of the network, managing building can be the bases for giving answers to multipurpose questions of countryside. The actual analysis takes a position on network techniques of water management buildings, piezometric tower, as presidium of village border and small district located as nodes of the network and that still contain interesting modernity episodes to be recovered. The taxonomic framework actually elaborated is strictly linked to village and its “water obsession”, and it wants to be a methodological approach in a meta-project point of view, based on the analysis of transformation process of water control techniques. It starts with the identification of village position partitioned in plain villages and hillside villages, analysing relationship with water fabrics, canals, streams and ponds, going to identify the techniques to control water resources at different scales.

The analysis shows the absolute centrality of water theme in Sardinian villages and the strong capability to transform territory and building architectures. The same villages work like a water control system at a different scale, located on a terraces arrangement, in such a way that water could slowly flow; the houses position and the walls define water corridors depending on the height of nearest wall, built in a way to flow water in the countryside. The land arrangement depends on soil nature and cultural typologies; the techniques identified are: terracing, cavalcappoggio and rittochino. Through this techniques countryside manages the slope and rules water flow. This palimpsest shows a strong
relationship between village and countryside; the water has the important role to become a link between inside and outside and the practices of dwelling and those of production.

Figure 3. Taxonomic framework of relationship water-habitat divided in the case of slope (S) and plain (P). The image shows different characters of relationship. S1 explores the case of the village in contact with river; S2 is the case of village with flowing way, crossed by the water, S3 is the case of terraced village. Also in the case of plain the distance between river and settlement is an important discriminante in partition; P1 explores the case of a river that cut in two parts a village, P2 and P3 explores two different distances transformed by human work, the first is that of specialized agriculture garden, the second is that of the canals of reclamation. Building of a multiscalar framework signifies understanding the importance of water techniques in transformation processes between technologies and settlements.

5. CONCLUSIONS

After the breaking countryside-settlement and countryside-resources, today it seems necessary to understand the correct working of direct relationship between parts, the technologies that manage water control and the role of traditional building cultures, continuously source of techniques obeying to necessity rules. The research in the next months will focus on case study
analysis, in order to understand the possibility to recover the artefacts in order to redefine the relations between village and water, often in crisis due to regardless expansions of ‘70s and ‘80s. The possibility offered by water control techniques is that of reflecting on long scale of definite forms and building techniques of architecture, that are examples of a type of sustainability not only linked to materials but also in the prolonged use during the centuries. Long-time of weak context represents a model of process sustainability, and today it is important to build an historical memory that aims to define guide lines for project and recovery.

6. REFERENCES