

Vulnerability and water management

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Introduction

This study was conducted as part of a research programme entitled CRIQUE “Hydraulic Crises and perception of environmental risk” which calls on different research teams from six Mediterranean countries (Algeria, Morocco, Tunisia, Spain, Portugal and France). More precisely, this programme aims to analyse the risks connected with agricultural irrigation and the manner in which risk is perceived and managed by the local people involved. It is carried out in the countries surrounding the Mediterranean and adopts an approach comparing North and South through the creation of a database of surveys.

For this study, a method was favoured that approaches the concept of risk through the notions of control, vulnerability, dependence or confidence. Two lines of enquiry in particular were selected:

- The social dimension of the relationship to irrigation techniques, from the techniques practiced to the experience of risk; or, in other words, a description of the social logic of using of these techniques (control, fragility, dependence, uncertainty and anticipatory behaviour).
- The socio-technical dimension of the relationship with environmental risk; or the manner in which water management measures take risk into account. Do these measures reduce or increase vulnerability?

The question of risk takes on an added dimension in the Mediterranean, where climatic hazards reinforce the palpable nature of the crisis and where the uneven division of resources and therefore of shortages, contributes to an increase in competition between agricultural irrigation and other uses of water. Our study looks at one of the social categories actively involved in water management: irrigating farmers. Through closed questionnaires and interviews, an attempt is made to understand the logic that determines their use of a resource, to identify their irrigation techniques and to analyse the degree of vulnerability of their system of water use.

After having outlined in more detail the steps taken to examine the perception of irrigation-related risk, the different links between vulnerability and irrigation in each country will be developed. Then, on an individual level, how vulnerability is distributed into different characteristic types of risk and how irrigation affects the way vulnerability manifests itself will be analysed.

1. A comparative analysis of irrigation-related risk in Mediterranean countries

1.1. Water management as risk management

Water management is risk management *par excellence*, as its final aim is to reduce natural as well as technical hazards. Although a daily concern, risk often gives rise to critical episodes which constitute constructive moments for analysis. The risk in question is neither a risk in itself nor a simple social construction. Rather, it designates the social as well as physical manifestations of a vulnerability that can be qualified as socio-technical and that is expressed through excesses, within a relatively stable situation, which take the form either of an unexpected event (drought, flood or usage conflict), or of a management crisis due to the emergence of new norms, of uncertainties or of controversies (such as the imputation of liability in the case of pollution).

As previously described, the aim of this research paper is to understand what risk represents in a socio-technical system dependent on water. The study's approach rests on two hypotheses concerning the reaction of irrigating farmers to the hydraulic crisis and the emergence of environmental risks:

- there is a link between the experience of risk and levels of technical capability: the study seeks to validate the proposal that the greater the increase in technical capabilities, the greater the experience of risk; but also, and especially, it attempts to see how, through the articulation of these two elements, the farmer identifies and prioritises his problems and how he finds solutions to them (the ability to anticipate risk, for example, depends on this).
- The framework for re-interpretation is both varied and complex, as it calls on cultural schema, socio-technical measures and professional and social networks. A challenge to social and professional identities can be expected.

1.2. The questionnaire and the analysis

The study's approach counted three steps. After a stage of open interviews intended to identify those concerned and their problems, a common questionnaire was constructed for all the areas of field research, nine in all. The second step, the closed questionnaire, aimed at understanding how irrigating farmers identify and prioritise the problems caused by the hydraulic crisis and the growing and associated experience of an irrigation-related environmental risk.

The questionnaire data was structured in an SPSS database. This survey is made up of 565 individuals and 311 variables.

The statistical analysis of such a corpus, the third step, enables the production of analytical hypotheses in a truly comparative situation. The statistical breakdown applies two types of treatment: one uses a cross-tabulation, employing the chi-square distribution principle (on SPSS) and the other makes use of correspondence factor analyses carried out on Tri-Deux software.

Drawing on the questionnaire database, the responses (variables or variable modalities) which enabled the construction of new synthetic variables were retained. The construction of these variables is based on the "occurrence principle". Sixteen variables

were created: six expressing constraints, six problem-solving strategies and four defining the relationship with others. The following section presents and analyses these synthetic variables.

1.3. Risk: a social and technical construction

Working on the basis that the social and technical construction of risk is a case of an individual faced with reasoning different “problems”, three dimensions of vulnerability were identified: environmental, socio-technical and economic. Environmental vulnerability is associated with issues relating to the quantity and the quality of water. Socio-technical vulnerability is concerned with problems linked to irrigation techniques and more globally to water management concerns. Finally, economic vulnerability covers production issues, whether on a farm-wide or market-wide scale.

The social and technical construction of risk also corresponds to a social logic, generated by a context of uncertainty concerning the behaviour of other people concerned. This societal uncertainty takes place at different levels, from that of the individual to that of the society. Four modalities of the relation to others are considered:

- Is the individual autonomous or dependant?
- Does the individual avoid or participate in the collective?
- Is the individual confident or defiant when faced with public institutions?
- What is the individual’s attitude to other worlds – open or closed?

The social and technical construction of risk relates back to problem-solving strategies, which can be structured into three ranges: technical, adaptive and cognitive. In the technical range, the solutions focus on implementation methods: the quality of technical equipment and the level of technical capabilities. The adaptive range which is linked to the domain of the action, groups together the level of resilience and the level of innovation. The third, cognitive range is based on conceptual perception, identified either by the adhesion to the intensive model or by environmental awareness. This study seeks to ascertain how all of these variables are distributed on national levels.¹

2. Vulnerability and irrigation: national disparities

After presenting the three dimensions of vulnerability, the issues and problem-solving strategies found will be analysed according to the country. Subsequently, the role of irrigation in the way these vulnerabilities manifest themselves will be discussed.

1. Despite the sentence “national level”, these results are not intended to be representative of each country as the sampling technique was not constructed with this aim. This method aims merely to locate the survey in a certain place: the reference to the country is merely indicative and possibly a source of hypotheses.

2.1. The positioning of the Mediterranean countries in the expression of vulnerabilities

A preliminary cross-tabulation of the national contexts with the variables expressing different “problem” logics demonstrates the particular link that the irrigators of different countries studied have with the vulnerabilities defined.

Environmentally speaking, an extremely contrasting situation appears between the Spanish irrigators, who have to deal with problems relating to both the quality and quantity of the resource and Portuguese irrigators who seem not to be affected by these questions. The French and Algerian irrigators are only aware of quantity related issues, whereas Moroccan irrigators are sensitive to quality problems. It is to be noted that no analysis could be made for Tunisia.

On the socio-technical front, the French and Portuguese irrigating farmers are not very vulnerable. Conversely, the Moroccan irrigators are particularly vulnerable. The Tunisian farmers are especially concerned with problems linked to irrigation techniques, whereas this is less true for Algerian and Spanish irrigators who are particularly affected by water management issues.

From an economical point of view, the results are less conclusive but the Portuguese irrigating farmers stand out as more solid than the other countries. High economic vulnerability is only expressed in Morocco and Tunisia but not for the same reasons, as one suffers from problems connected to farms and the other from market related issues. It is to be noted that no results for Spain came out of this cross-tabulation.

More generally, it is possible to highlight extreme cases: Morocco finds itself in a context of high vulnerability as opposed to Portugal which conveys low vulnerability. In terms of attitudes to problems, no marked North/ South divide appears as Spain finds itself more affected by converging pressures than Algeria and Tunisia.

2.2. Mediterranean countries with different socio-technical contexts

Risk is not solely constructed by attitudes towards problems. It is also necessary to take into consideration the problem-solving strategies the farmers put into action, as well as their relationship with society. These can increase or reduce the vulnerabilities identified previously.

The North/ South divide is more visible in this case. The northern countries come out of the chi-square analysis as endowed with highly structuring systems (technical, adaptive and cognitive). Conversely, the analysis underlines that the southern countries work within a less structured, less homogenous framework. Among the northern countries, the French farmers have the biggest margin for manoeuvre, technically as much as adaptively, although slightly cognitively speaking. The Portuguese farmers are in a similar situation but their assets are the quality of equipment and their environmental awareness. The Spanish farmers have less room for manoeuvre, limiting themselves to a strong adhesion to the intensive model. Among the southern countries, the problem-solving strategies are much less diverse. Algerian farmers respond to problems by innovating, whereas Tunisian farmers fall back on technical skills. The Moroccan farmers seem to have no margin for manoeuvre.

As regards societal relationships, the North/ South divide endures. A relationship to the collective is only evident in the northern countries. The collective is further reinforced by a relationship of trust with institutions on the part of Spanish and Portuguese farmers. French farmers are more autonomous. In the southern countries, a relationship with the collective or with institutions does not appear in the results, which is a sign of a possible situation of anomie. This strongly affects Moroccan farmers for whom rules and social norms, whether individual, collective or institutional are no longer perceived as operative. Tunisian and Algerian farmers suffer less from this, responding with autonomy, reinforced by openness to other worlds in the case of the Algerians.

2.3. The positioning of irrigation in how vulnerabilities are expressed

The cross analysis that can justifiably be carried out between the gradient of vulnerability (as in “problems”), and the gradient of irrigation offers a first indication on the question of risk. The Spanish and Moroccan farmers, who irrigate the most respectively, live in the countries which experience the greatest vulnerability. Conversely, Portuguese and French farmers, who irrigate the least, are in countries that are the least vulnerable to water questions, in terms of all the dimensions described. In the median position are the Tunisian and Algerian farmers. In other words, *the large role that irrigation plays in the production system appears, at least at the level of the perception that the irrigating farmer has of it, to be an aggravating factor of risk or at least of the fragilities that ones system of production can generate.*

Having located the way vulnerabilities are expressed and the different problem-solving logics in their national contexts, this approach will be applied on an individual basis, while at the same time positioning these individuals in the country they farm in.

3. Irrigation and the characteristics of risk

The objective here is to highlight the dominant characteristic of the way risk is expressed in individual cases and to test the hypothesis that has come out of the analysis of national configurations, concerning the fragility brought about by irrigation.

3.1. A divide between farmers marked by the level of autonomy and of technical capabilities

The synthetic variables selected were the subject of a correspondence factor analysis, based on groups of individuals, 565 in total. This analysis allowed the construction of a typology of characteristics of risk. The first axis is defined by the level of autonomy, high or low. The second axis, in a lesser measure, is defined by the level of technical capabilities, high or low. The fact that technical skills stand out from the analysis to determine an axis underlines that the risk in question is of a technological nature, inasmuch as these practices presuppose particular equipment or skills. In this factorial analysis, four types stand out, each expressing the dominant characteristic of risk for the individual.

The two first types influence the first axis; one determined by “dependence”, the other by “independence”. The two others are determined by the second axis, which opposes the category of “solidity” with “fragility”. Thus, this vulnerability is not unambiguous: it is expressed in a variety of characteristics of risk, which indicates the greatest area of weakness, or more exactly of sensitivity, in which the relationship to risk is composed.

Once the types were defined, a cross-tabulation was carried out with the country the farmers work in. Here a North/South divide appears clearly, with the northern countries represented, in their majority by characteristics of *dependence* and *solidity*, whereas the South is expressed through characteristics of *fragility* and *independence*.

More precisely, *solidity* (a high level of autonomy and technical competences) is shared by the French farmers and to a lesser extent by the Portuguese, while *dependence* (strong technical skills but low autonomy) is characteristic of the Spanish farmers. In the southern countries, *fragility* (accumulated weaknesses of autonomy and technical skills) especially affects the Moroccan farmers, whereas *independence* (high autonomy but low technical capacity) is shared by the Algerian farmers. It is to be noted that the Tunisia is not involved in this divide, as the Tunisian farmer are spread over all four of the characteristics defined.

3.2. Irrigation: a vector of vulnerability?

Does this reading of the dominant characteristic of risk for individual farmers confirm the hypothesis concerning the role played by irrigation in the way vulnerabilities manifest themselves?

The characteristics of *fragility* and *independence* certainly appear to be the expression of a vulnerability linked to large-scale irrigation. To a lesser extent, *dependence* can also be found here.²

Only the characteristic of *solidity* is linked to moderate irrigation, *which implies and confirms that irrigation does not play a role in reducing vulnerability*. When irrigation holds a lesser place in the system of production, it can be hypothesised that irrigation shares the structuring of vulnerability with other factors, such as the diversification of production.

3.3. Irrigation-linked risk in the Mediterranean: convergence and divergence

The suggested typology therefore allows the identification of characteristics of risk that have been positioned in relation to irrigation practices. This measure can now be refined by identifying the dominant vulnerability according to the different characteristics. Again, a cross-tabulation between the individual approach and the approach of

2. At this stage, it would be interesting to introduce the level of intensification of the systems of production in order to better understand how irrigation plays a role. This being said, the link between intensification and irrigation is obvious but deserves to be evaluated in terms of the whole system of production which can be affected by other parameters such as the diversification of production.

national configurations has been carried out: this last variable should be considered with precaution as has been recommended before.

Independents are faced with problems related to the market whereas *dependents* are sensitive to environmental problems, as much in terms of the quantity as the quality of the water resource. Finally, *fragiles* accumulate both technical and environmental problems.

Among the different problem-solving strategies, the analysis highlights an opposition between the farmers with little margin for manoeuvre, represented by *fragiles* and *independents*, with the farmers possessing a certain number of solutions, represented by the *solids* and the *dependents*. Although these two last types both have a problem-solving strategy centred on technical capacity, *dependents* find solutions through innovation while *solids* prefer solutions based on resilience.

In their relationships with others, the *independents* and the *solids* both pursue situations of autonomy, as opposed to the *dependents* who tend to delegate to the community and to institutions. The *fragiles*, on the other hand, are affected by a certain anomie.

Conclusion

The aim of this analysis was to understand the relationship to risk of irrigating farmers. First, the risk in question is of a technological nature, if such a practice presupposes equipment and particular technical knowledge that are hypothetically uneven in different countries. The social and technical construction of risk has been shown to be a case of confrontation with the uncertainty of the market, of technological complexities and of natural hazards. Each individual is more or less exposed to these uncertainties, creates a hierarchy of them and takes them into account in order to reduce them through different problem-solving strategies; that is, unless he or she uses them as a base from which to orient personal initiatives (innovation for example) or contacts with others (investing in the collective). Although these are only the first results, certain salient facts emerge, whether at a region-wide or individual level.

This analysis tends to *undermine the initial hypothesis*, according to which higher technical capacities would increase risk perception and the experience of vulnerability. As has been demonstrated, whether at a national or individual level, irrigation is decisive in the expression of risk, which takes a different characteristic according to the situation; sometimes economic, at other times environmental or cumulative (technical vulnerability plays a particular role in this latter). But we must be careful. In the case of Morocco, where *fragiles* are most common, irrigation is widespread but of a low level technically-speaking; compared to the situation in France, for example, which is the opposite. Isolating elements linked to the level of technical capability and to the importance of irrigation in the production system is therefore a delicate process. However, it can be concluded that *large-scale irrigation associated with low level technical capability is a factor of vulnerability*.

Vulnerability does not merely come down to technical capabilities but depends on the local water management context, in terms of networks, access or availability of the resource. Individual reaction capacity, which can be very different according to the

socio-technical context of irrigation practises, comes into play. Although innovation appears as a solution to a situation of *dependence* which expects a great deal from institutions and the collective (as in the Spanish case), resilience, as an adaptive capability, is the response of the privileged that demonstrates a quest for individualisation (as in the French case). At a regional level, North/ South divides seem to emerge from this study and deserved to be further studied. The North comes out of the analysis as less vulnerable, drawing strength from technical, cognitive and social processes. Conversely, the South seems more vulnerable with a risk of anomie (more in the west than in the east); it could even be faced with a model crisis, as such reflecting a society characterised by defiance.

Finally, a region-wide line of enquiry could be pursued in the Mediterranean area to understand how risk can be constructed either with a view to *risk-taking*, through an arbitration between the different characteristics of vulnerability and the solutions found for them; or according to an *insurance-based* strategy, through productive configurations that can affect adjustment variables, such as livestock farming and market gardening, or technical, social and cognitive resources. Our data must be interpreted on the gradient between a policy of risk-taking and an insurance-based strategy, in order to confirm or undermine our key, but provisional, result: *irrigation increases individual vulnerability, when it is not incorporated into a solid, nation-wide structure and a supportive local water management context.*