

**DESERTIFICATION AND MIGRATIONS IN THE WESTERN
MEDITERRANEAN: ENVIRONMENTAL OUTCOMES OF THE INVERSE
FLOW OF PEOPLE AND CAPITAL**

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**DESERTIFICACIÓN Y MIGRACIONES EN EL MEDITERRÁNEO OCCIDENTAL:
CONSECUENCIAS DE LOS FLUJOS INVERSOS DE POBLACIÓN Y DE CAPITALES**

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Resumen

Desde principios de la década de los noventa, los intelectuales vienen alertando de la notoria aceleración del crecimiento de los índices demográficos y económicos de las zonas del norte de África y los países de Europa y de las consecuencias del flujo de migraciones. Quince años después, estas predicciones se confirman.

En lugar de tratar lo intrincado del proceso de las migraciones en los países de origen y de acogida, esta contribución se centrará en una cuestión en particular: el impacto en el medioambiente del flujo migratorio de personas del Sur hacia el Norte y en sentido contrario, el flujo de dinero del Norte al Sur. Así pues, se adoptará un enfoque más minucioso considerando la situación de unos determinados oasis en Marruecos y Túnez, así como, la agricultura intensiva que se da en la costa española.

Se adoptará una base de conocimiento conceptual, en la se que considere la desertificación como un gran obstáculo para la sostenibilidad del sistema de recursos humanos renovables, debido a ciertos cambios que se manifiestan con el transcurso del tiempo. Éstos pueden ser de tipo climático, demográfico, económico, tecnológico, institucional, etc. Sin embargo, el efecto que producen es el mismo: la sobreexplotación incontrolable de los recursos.

La agricultura en los oasis evoluciona mediante una compleja interacción entre normas sociales e institucionales que tienen como objetivo el uso eficaz de los recursos hídricos, sobre todo porque siempre fueron puntos de comercio o venta en las rutas transaharianas. El crecimiento demográfico interno y el fin de la tradicional actividad en caravana estimularon la emigración desde el oasis. En los años setenta, Francia fue el principal país receptor de inmigrantes mientras que a finales del siglo, España seguido de Holanda e Italia fueron los países que recibieron más inmigrantes, y más del 30% de la población masculina se encontraba fuera de su ciudad natal.

La mayoría de los inmigrantes que provienen de los oasis que se han estudiado desempeñan trabajos no especializados en agricultura y construcción. En el sudeste de España, la agricultura costera de riego experimenta un crecimiento acelerado desde los años setenta, en la mayoría de los casos, sobrepasando el umbral de sostenibilidad, ya que el gasto de agua es entre 2 y 5 veces mayor del que debería. Sería posible reducir la velocidad de crecimiento, sin embargo, no se dispone de un mecanismo de reacción para controlar esta aceleración. En este sentido, se experimenta un aumento de la oferta tanto en puestos de trabajo como en y mano de obra. El resultado es doble: por una parte, bajos costes de mano de obra y altos ingresos por unidad de volumen de agua de riego. El resultado de esta combinación es un riesgo mayor de agotamiento de los recursos hídricos.

Los emigrantes envían remesas a sus familias ayudándolas de esta forma a incrementar sustancialmente sus ingresos y crear capacidad de inversión. Estas familias pueden adquirir bombas de agua y tierras en otros lugares diferentes a los oasis de origen. Este proceso se lleva a cabo de manera individualizada y, a menudo, termina con el antiguo sistema agrícola y descuidándose la gestión del agua. El resultado es una mayor desintegración de la sociedad falta de recursos institucionales locales que servirían para paliar los nuevos riesgos, sobreexplotación de aguas subterráneas y la salinización del suelo, debido a la falta de gestión de drenaje.

La conclusión es que los flujos invertidos de personas y capital, en la parte occidental del área del Mediterráneo, tienden a perjudicar la integración de sociedades de agricultura intensiva y el establecimiento de regulación interna de mecanismos para controlar la sobreexplotación y la degradación de sus propios recursos. El resultado global es un riesgo mayor de desertificación.

**DESERTIFICATION ET MIGRATIONS EN MEDITERRANEE OCCIDENTALE:
CONSEQUENCES DES FLUX INVERSES DE POPULATION ET DE CAPITAUX**

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Résumé

Depuis le début des années 90 du siècle dernier, les experts ne cessent de tirer la sonnette d'alarme à propos de l'augmentation des glissements démographiques et économiques en provenance d'Afrique du Nord et en direction des pays de l'Europe du Sud et leurs conséquences sur les taux de migration. Quinze ans après, ces prévisions se confirment. Plutôt que de s'attacher à toutes les intrications de ce processus migratoire dans les pays sources et récepteurs, cette étude portera sur une question spécifique: les conséquences en matière d'environnement des flux de population Sud-Nord et les flux de capitaux inverses Nord-Sud sous la forme de mandats. A cet effet, nous opterons pour une approche microéconomique en examinant la situation dans plusieurs oasis marocains et tunisiens, ainsi qu'à travers l'agriculture intensive côtière en Espagne.

Nous nous orienterons vers une approche conceptuelle, dans nous considérerons la désertification comme un obstacle au développement durable dans le système des ressources renouvelables, en raison de bouleversements qui n'existaient pas par le passé. Ces bouleversements peuvent être de nature climatique, démographique, économique, technologique, institutionnelle, etc. Ils ont tous en commun de donner lieu à une surexploitation incontrôlée des ressources.

L'agriculture des oasis a évolué dans un mélange très complexe de réglementations sociales et institutionnelles visant à l'utilisation efficace des ressources en eau disponibles. Par ailleurs, les points de vente ou de distribution ont toujours existé le long des routes commerciales transsahariennes de long cours. L'augmentation de la démographie interne et la disparition de l'activité traditionnelle du caravaning ont stimulé le phénomène d'émigration des oasis. Alors que dans les années 70, la France constituait le plus grand pays récepteur, à la fin du siècle l'Espagne était devenue la destination phare, suivie des Pays-Bas et de l'Italie, et on comptait plus de 30% de la population masculine hors de son village d'origine.

La plupart des migrants issus des oasis étudiés travaillent dans des activités non spécialisées du secteur agricole et dans la construction. Dans le sud-est de l'Espagne, il existe une agriculture d'irrigation côtière très intensive qui se développe rapidement depuis les années 70. Dans la plupart des cas, elle dépasse le seuil de développement durable, puisque ses dépenses en eau sont de 2 à 5 fois plus élevées que ses entrées. Néanmoins son taux de croissance ne décline pas en raison du manque de réaction interne pour limiter sa croissance. Dans cette situation, on observe une augmentation simultanée de l'offre d'emploi et de la main d'oeuvre. Les conséquences sont donc doubles, à savoir des coûts salariaux bas et des rendements élevés par unité de volume d'eau pour l'irrigation. Cette combinaison a pour effet de faire augmenter le risque d'épuisement des ressources en eau.

Les migrants envoient des mandats à leurs familles, les aidant ainsi à augmenter de façon significative leurs revenus et à consolider leur capacité d'investissement. Les familles de migrants peuvent alors envisager l'achat de pompes et de terrain hors des oasis traditionnels. Ce processus est mené de façon très individualiste et a souvent pour effet de détruire le système agricole en vigueur et les délicates pratiques mises en place pour la gestion de l'eau. Par conséquent, nous sommes face à une société encore moins intégrée et qui manque de ressources institutionnelles locales qui puissent prendre en charge ces nouveaux risques, cet épuisement des eaux souterraines et salinisation des sols due au manque de gestion des techniques de drainage.

En conclusion, on soulignera que les flux inverses de population et de capitaux dans la région Méditerranéenne occidentale tendent à freiner l'intégration des sociétés basées sur l'agriculture intensive ainsi que la mise en place de mécanismes de réglementation internes pour contrôler la surexploitation et la dégradation de leurs propres ressources. La conséquence majeure de cette situation est donc l'augmentation du risque de désertification.

Abstract.

Since the early nineties in the last century, scholars are warning about the dramatic increase of the demographic and economic gradients from northern African to southern European countries and their consequences to the migration rates. Fifteen years after those predictions are becoming confirmed. Rather than looking at the whole intricacies of this migration process in the source and receptor countries, this contribution will focus on a particular issue: the environmental outcomes of the S-N flow of people and the inverse N-S flow of capital as remittances. To this purpose a micro-approach will be adopted by considering the situation in a set of oasis in Morocco and Tunisia, and in the coastal intensive agriculture of Spain.

A conceptual background will be adopted, in which desertification is thought as a break of sustainability in the human-renewable resources system, due to disturbances that were not incorporated in its previous history. Such disturbances may be climatic, demographic, economical, technological, institutional, etc. Their common effect is that produce an uncontrolled over-exploitation of the resources.

Oasis agriculture evolved in a very complex patchwork of social and institutional regulations that aimed at the efficient use of the available water resources. Besides they often were market or release points in

the long-term commercial trans-saharian routes. Internal demographic increase and fading of the traditional caravaning activity stimulated the emigration from oasis. While in the seventies, France was the main receptor country, at the end of the century the main destination was Spain followed by the Netherlands and Italy, and more than 30% of male population was out of their home villages.

Most migrants from the studied oasis take non-specialist jobs in agriculture and construction. In southeast Spain there is a very intensive irrigated coastal agriculture that is growing quickly since the seventies of the last century. In most cases it is beyond the threshold of sustainability, as its water overdraft is 2-5 times over the inputs. However its expansion rate does not decay because of the lack of internal feedback to limit its growth. In this situation, there is a simultaneous increase of offer in both jobs and manpower. The outcomes are twofold, low labour costs and high returns per unit volume of irrigation water. The consequence of this combination is an increased risk of water resource depletion.

Migrants send remittances back to their home households helping the latter to increase substantially their income and building their investor capacity. Households with migrants can purchase pumps and land out of the original oasis fields. This process is run in a very individualistic way and often destroys the previous agricultural system and its careful practices to manage water. The outcome is a more disintegrated society that lacks of local institutional resources to take care of the new risks, overdraft of ground water and soil salinisation due to the lack of drainage management.

The conclusion is that the inverse flows of people and capitals, in the West Mediterranean area, tend to impair the integration of intensive agricultural societies and the establishment of internal regulation mechanisms to control overexploitation and degradation of their own resources. The overall outcome is an increased risk of desertification.

Introduction.

Since the early nineties in the last century, scholars are warning about the dramatic increase of the demographic and economic gradients from northern African to southern European countries and their consequences to the migration rates (Le Houerou 1992 Mendizabal & Puigdefabregas 2003). Fifteen years after those predictions are becoming confirmed. Rather than looking at the whole intricacies of this migration process in the source and receptor countries, this contribution will focus on a particular issue: the environmental outcomes of the S-N flow of people and the inverse N-S flow of capital as remittances. To this purpose a micro-approach will be adopted by considering the situation in a set of oasis in Morocco and Tunisia, and in the coastal intensive agriculture of Spain.

A process approach to desertification.

A conceptual background will be adopted (Fig. 1) in which desertification is thought as a break of sustainability in the human-renewable resources system, due to climatic and socio-economic disturbances that were not incorporated in its previous history. Climatic disturbances include droughts, rain spells, etc. Socio-economic disturbances involve demographic, political, institutional, market and technological changes that enable or hinder access to those resources. (Puigdefabregas and Mendizabal 2004).

Under steady-state conditions, the intensity and duration of disturbances remain within the range that occurred throughout the history of the system. They have been incorporated into its own evolution, in such a way that it recovers quickly after they have ceased.. However. A new or very extreme disturbance or combination of disturbances may occur that brings the system beyond its threshold of sustainability.

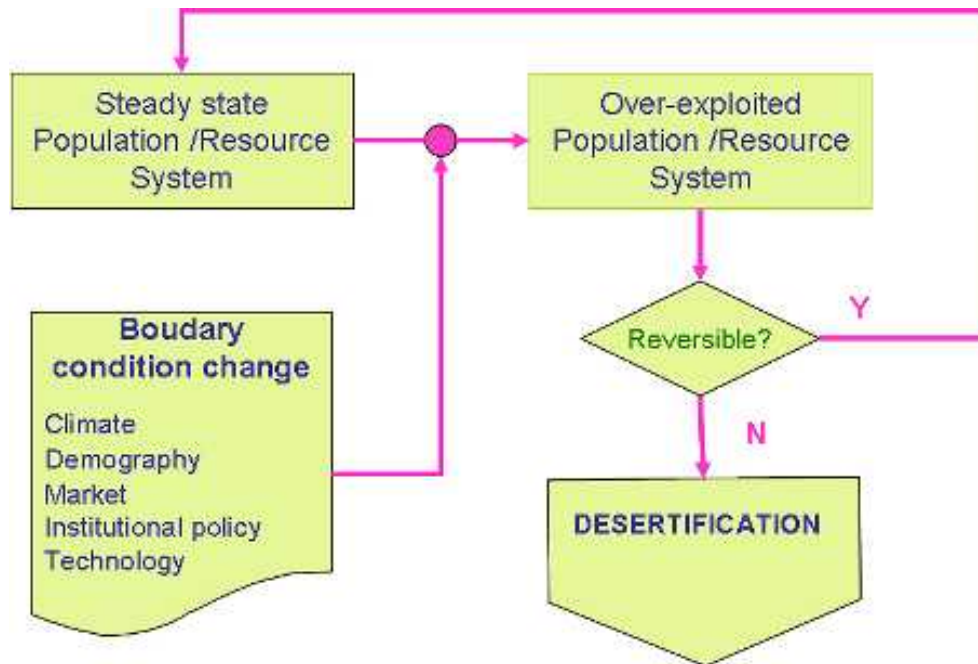


Figure 1. Perceptual model of desertification. *Source: Puigdefabregas & Mendizabal 2004.*

This may happen as an increased availability of resources (i.e, due to an humid period or to the introduction of new technology), an increased demand for products (i.e, due to higher prices or population increase), or on the contrary, as a reduction of available resources (i.e, due to an extreme drought).

In both cases, the resources become over-exploited. If the system is endowed with feedback mechanisms to reverse this condition, it can recover and return to the steady state. Otherwise it falls into an over-exploitation loop that leads to its own extinction. This process, when happens in drylands, may be considered the core of desertification (Puigdefabregas 1995, 1998).

A growing N-S economic gradient.

The socio-economic differences between the northern and southern countries increase with time. Comparing data from Southern and Northern countries during the 1963-1996 interval (Mendizabal and Puigdefabregas 2003) and Fig 2, total population in the former increased 6 times that of the latter; arable land area decreased 14% in the North and increased 21% in the South, while sheep stock in the South increased 6 times that of the North. Cereal yield and fertilizer consumption was stagnant in the South whereas more than doubled in the North. Per capita Gross Domestic Product (GDP-pc) increased around 50% in the North and remained nearly stagnant in the South.

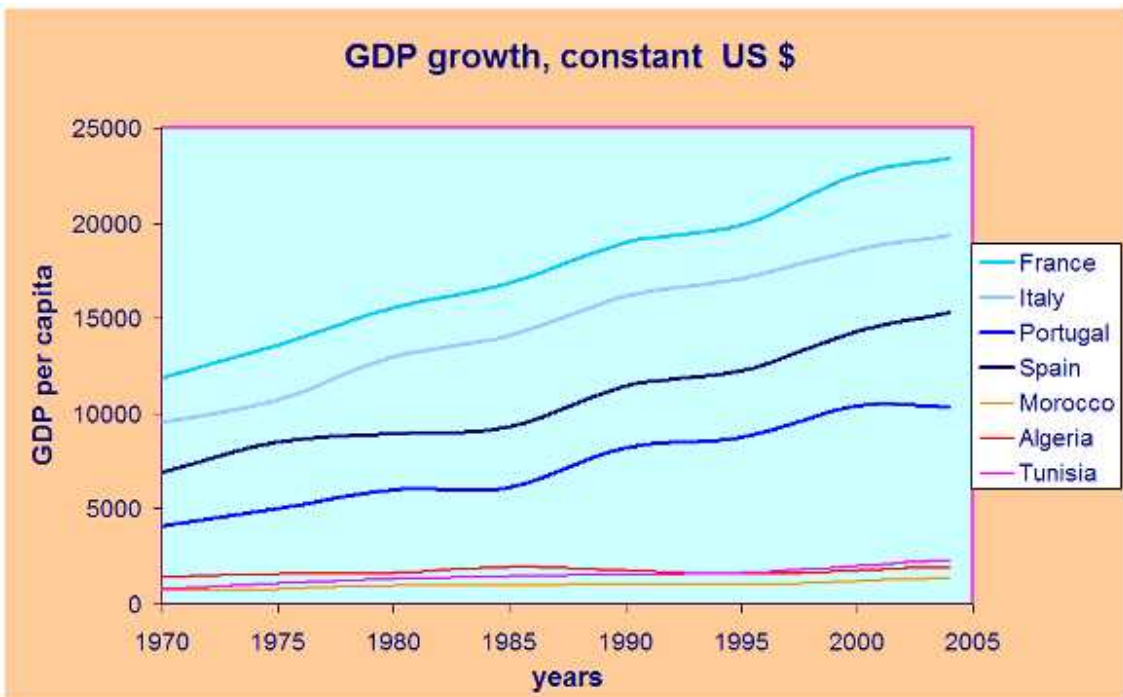
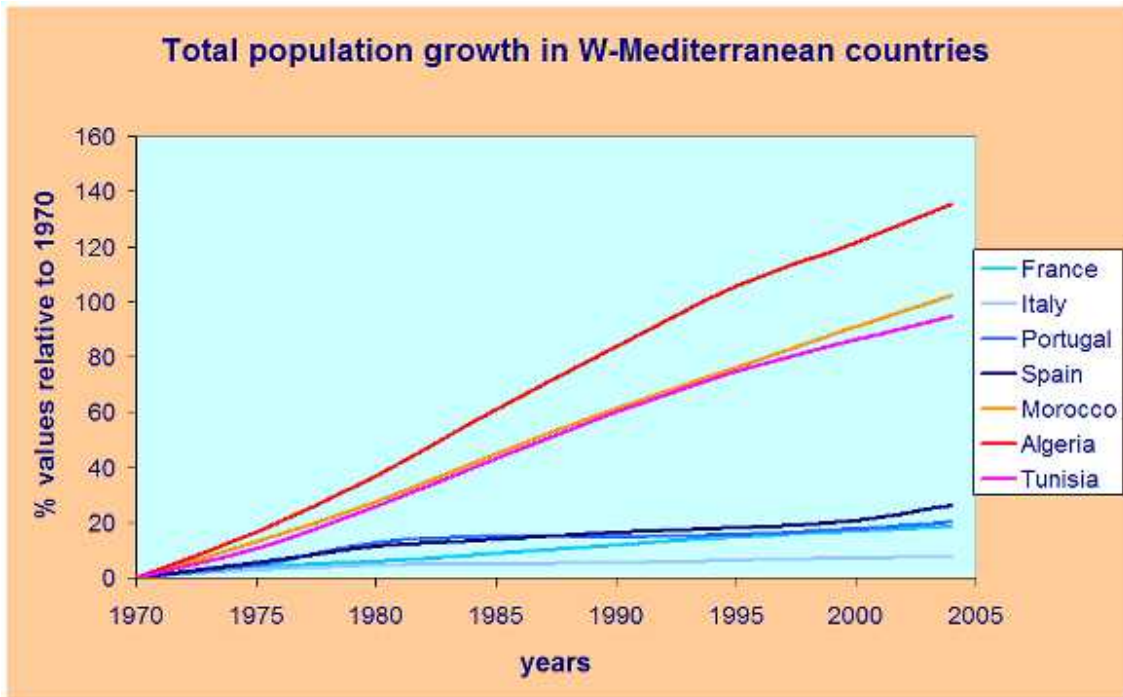


Figure 2a: Socio-economic trends in W-Mediterranean countries. *Source: Eearth Trends*

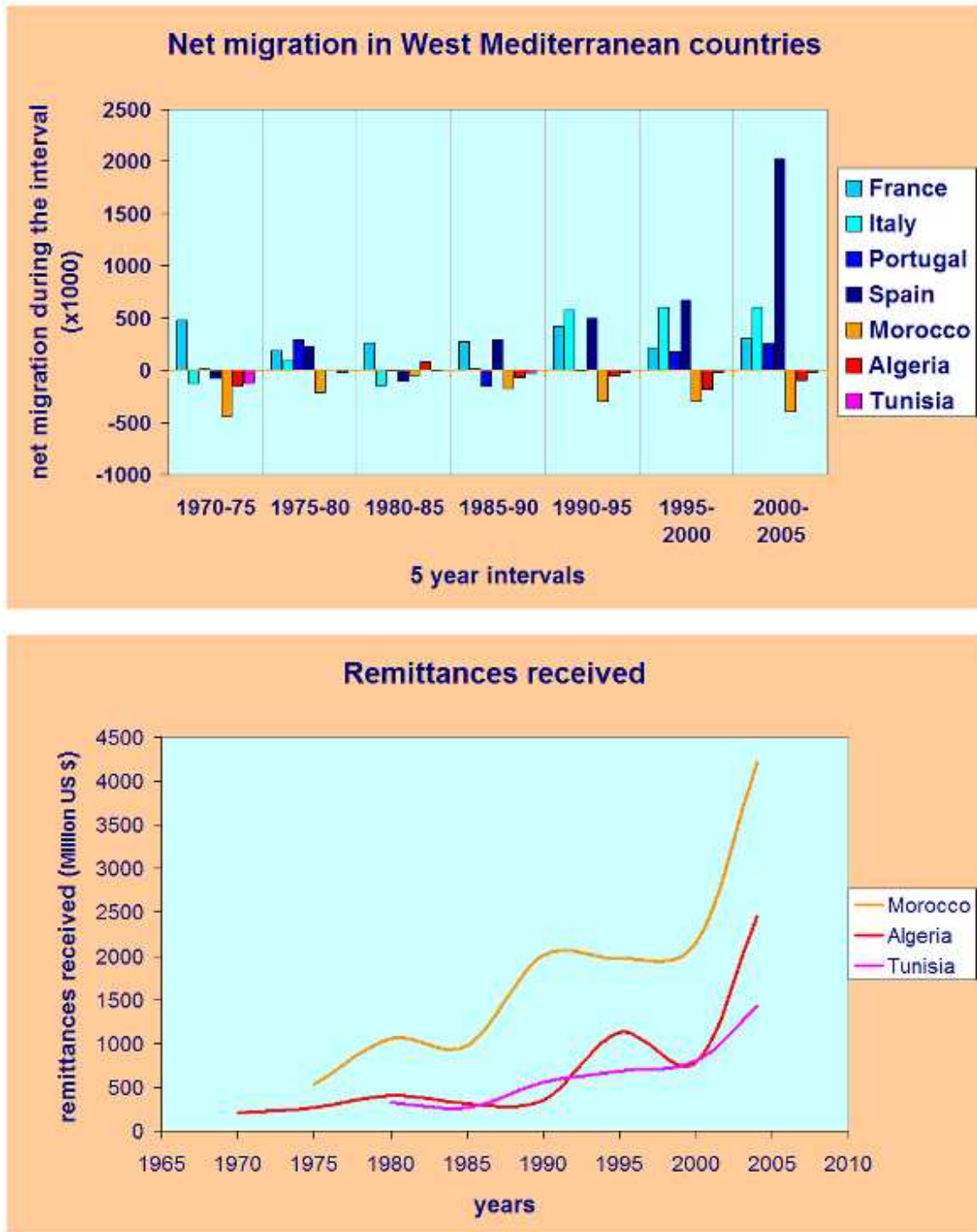


Figure 2b: Socio-economic trends in W-Mediterranean countries. *Source: Earth Trends*

In this situation in the Southern countries, where population increases faster than GDP-pc and agricultural yield, it becomes obvious that poverty and unemployment (Le Houerou 1992) drive the migration to the North (Fig 2b). The expansion of agriculture and stock ranging over steppes and shrublands lead to dramatic increases of soil erosion (Le Houerou 1992). The dramatic predictions of this latter author, 15 years ago, are being largely accomplished. However, the idea of desertification as a main driver of migration cannot be generalized. In Morocco, the three traditional migration sources (Rif, Sous and southern Atlas oasis) are not particularly affected by desertification (de Haas 2003) but have experienced foreign links due to either the European colonization (Rif, Sous) or the long distance nomad stock-breeders and transaharan caravanning

(oasis). These features enabled the involved populations seeking to improve their life standard when local population density increased beyond the capacity of their resources.

To this picture there is a factor that has been rarely taken into account concerning its impact on the renewable resources: The remittances that migrants send to their home lands. They experienced $\times 10$ increases in the last 30 years with an even higher rate in the last decade. Remittances are particularly important in Morocco where they attain 1.5 times of the total exports value (de Haas 2003). In the following we are going to trace the effects of this feature in both sources and receptors of migrant population.

Case studies.

Two well documented case studies have been chosen in Southern Spain (Campo de Dalías, Almeria) and in Central Morocco (Todgha oasis system) respectively to gain information about the environmental effects of migrations and remittances. The first is an example of recently developed intensive irrigated coastal agriculture, which takes advantage of the mild Mediterranean climate to grow early season vegetables. A significant body of technical and administrative information is available from this site. The second represents a traditional oasis with a long history of common regulations to optimize the use of local water resources. Data on the impacts of migration and remittances in this site have been obtained by the research project (IMAROM 2001).

Campo de Dalías (Spain)

In the Almeria province (southeast Spain), there is a very intensive greenhouse agriculture that is growing quickly since the seventies of the last century. Its area is approaching 500 km², of which 60% represent the share of the 'Campo de Dalías'. This is a compact development over a sedimentary pediment at the foot of the Gador coastal range, which karstified top provides the main infiltration site to feed the aquifers that support the greenhouse agriculture.

Until the sixties of the last century, the Campo de Dalías a barren shrubland used only for grazing, Thereafter the availability of pumping technology and of public funds made possible accessing to the underground water resources. This fostered the development of sophisticated agricultural systems that took the opportunity of its mild winter climate to grow very early season horticultural products. As a consequence, the area became an attractor of people and funds, first from its own hinterland, after from the rest of the country and for foreign migrants. In fact, Almeria changed from being a source to sink in terms of migration and nowadays it hosts around 100,000 migrants.



Figure 3: Remotely sensed image of 'Campo de Dalias' in Almeria, Spain, showing the greenhouse cover (white) and part of the hinterland mountains that collect rainfall that feeds the aquifers. *Source: NASA, Feb 2004.*

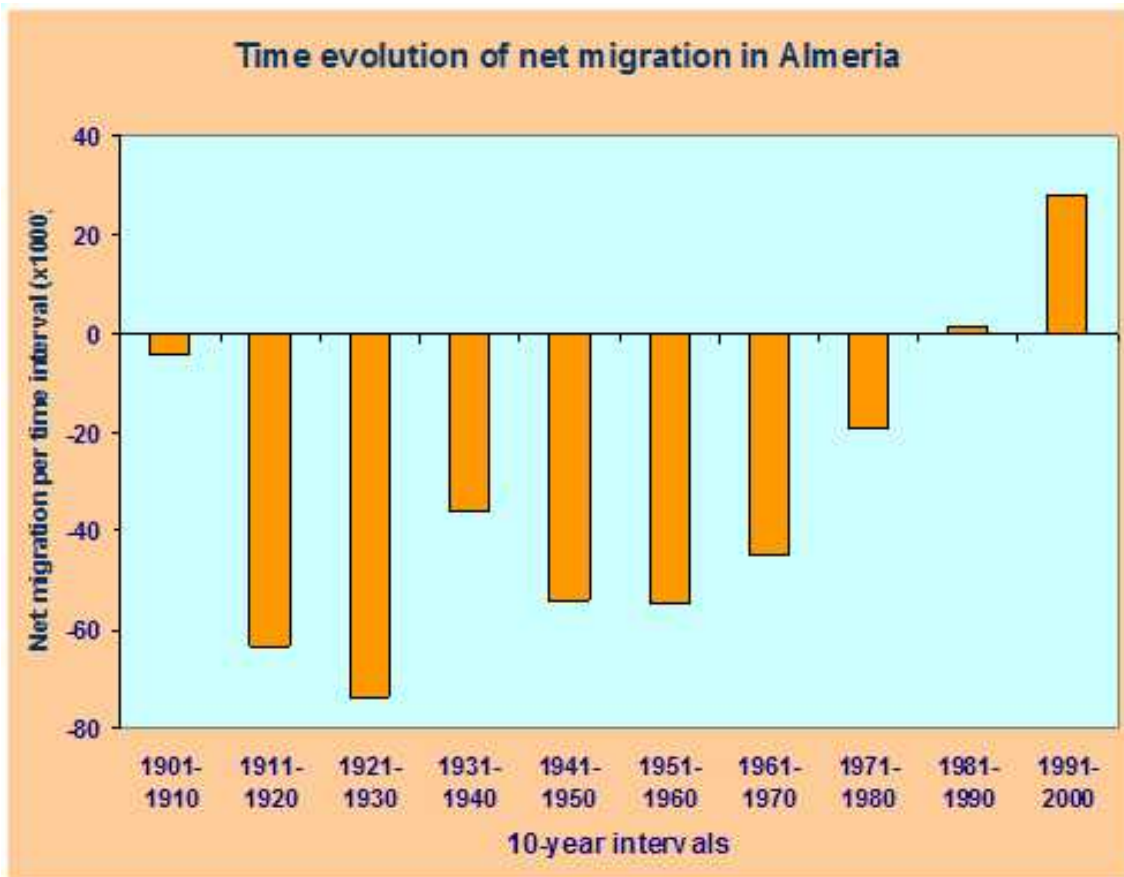


Figure 4. Net migration trends in Almeria, Spain. *Source: Pimentel 2002.*

The quick growth of this agricultural system and the lack of previous history in cooperative management of water resources, result in a prevailing individualistic and

competitive behaviour of households. The estimated natural recharge of aquifers is $52 \text{ hm}^3 \text{ y}^{-1}$ while the present annual draft rate of $142 \text{ hm}^3 \text{ y}^{-1}$ builds up an overdraft of $90 \text{ hm}^3 \text{ y}^{-1}$ (x 2.7 of water input) (Pulido *et al* 2003, Direccion General de Obras Hidraulicas 2004). Moreover there is a risk of dramatic increase marine intrusion and aquifer salinisation, which remains hidden by the poor connectivity between the aquifers due to the high tectonicity of the area.

The quality of water resources is downgraded by marine salt intrusion and by pollution with agrochemicals. The former affects the 80% of aquifers in the area (Direccion General de Obras Hidraulicas 1994) although its evolution is difficult to predict because of connectivity differences between aquifers and the sea (Pulido *et al* 1993). The latter reaches extreme conditions, for example, more than 100 mg l^{-1} in the ground water of some areas (Direccion General de Obras Hidraulicas 1994).

Some structural factors of the involved land use systems impair also these agricultural systems. One of them is sand supply, which is required by greenhouse agriculture, in Almeria, at a rate of $1 \text{ hm}^3 \text{ y}^{-1}$ (Muñoz 1991). The scarcity of sand sources leads to the exploitation of fossil dunes and apical areas of alluvial fans, causing important environmental problems. Almeria greenhouses produce around 1 Million Tm of fresh crop residues each year, and its recycling is still an unsolved problem. Incineration is expensive because it involves the removal of very large volumes. Using residues to feed livestock has the advantage of producing manure, an important input to greenhouses, but eliminating agrochemicals and plastic strings are expensive operations.

The Dalias agricultural system represents a widespread desertification syndrome in the northern Mediterranean coastal areas: non-sustainability of the use of water resources due to overdraft and lack of internal mechanisms to limit its own growth. This may be referred to desertification driven by new technological developments to access ground water resources and favourable market conditions to sell the agricultural production.

The first consequence of migration into the Almería greenhouse agriculture is increasing labour offer and, consequently, lowering its cost. Personal enquiry in Almeria shows that in 2006, the cost of labour per day in orchard agriculture is around 35 €, while in Murcia (Instituto de Credito Oficial) and Valencia (Institut Valencia d'Estadística), two provinces north from Almeria, is of 48 €

Labour is the main component of fixed costs per unit area (Fa), and its impact on the equilibrium of the greenhouse system in terms of changes of its state variables can be assessed using stability analysis in the frame of human-renewable resource systems like that of *Figure 1* (Ibañez J, S Martinez & J Martinez 2004). These authors found that increasing Fa leads to significant decrease of the ground water reserve while increasing the greenhouse area, the transition time to the steady state and the stability during the transition time. In other words, lowering labour cost moves the system to another equilibrium in which the individualistic competitive behaviour of households is stimulated. Consequently overdraft and larger greenhouse area occupancy bring the system even farther from sustainability conditions and increases desertification risk .

Todgha oasis (Morocco)

The Todgha is an oasis river valley located on the southern slopes of the High Atlas Mountains in Morocco. Its cultivated area, stretches along 40 km of the Todgha river. Its width varies from 100 m at the gorges to 4 km downstream with altitudes from 1430m to 1340m respectively (de Haas 2003). With an average annual precipitation of

143 mm at 1430 m altitude, its climate is of the cool Saharan type, with hot dry summers and relatively cold winters..



Figure 5. A view of the Todgha oasis along the river in its intermediate section. *Source: Albert Sole*



Figure 6: A view of the oasis characteristic three layered crop system (date palms, apricote trees and alfalfa. *Source: Albert Sole.*

Its agriculture is representative of most Maghrebian, with three levels of crops, an upper canopy stage with date palms, an intermediate one with small fruit trees (apricots, pomegranates, figs and almonds), and a ground layer of alfalfa, cereals and orchards.

The water supply ranges from direct river derivation in the upper sector, near the gorges, to pumping in wells in the lowest sector, through prevailing *khattara* systems in between. *Khattaras* are traditional hand made systems designed to catch water from the uppermost water tables and lead it downstream through underground pipes. The traditional oasis, as a whole, is a highly sophisticated agricultural system with many common regulations aimed at optimising water resources in a cooperative way

The Todgha population shows a dramatic increase (x 2.5 in the period from 1950-2000), much higher than in the 1880-1950 period, where it increased only by a factor of x0.5). The lack of land and water resources to support this demographic growth forced the emigration that nowadays accounts up to 7% of the population (de Haas 2003).

Most migrants send part of their income to their homeland families. These remittances more than double the original income of the receptor households and enable them, not only increase their live standards, but also buying pumps and new land outside of the traditional oasis (de Haas 2003).

The impact of the increased investor capacity by the households that benefit from remittances is escaping from the traditional common regulations of oasis. Private wells and pumps tend to replace collective ones, which numbers changed from 40% in 1975 to 6% in 2000. A survey made on 85 households (de Haas 2003) referred to the period 1975-1998, shows that while 79% of the purchasing acts involve migrants, there is a tendency to purchase land outside of the traditional oasis. While 41% of the purchases were made in the traditional oasis, these represent only 18% of the total purchased area. The remaining 82% is divided in a 17% of the area in recent extensions nearby the traditional oasis, and 65% of land bought as large plots outside the Todgha.



Figure 7. A view of a salinized oasis area where agriculture has been abandoned. *Source: Albert Sole..*

The increase of private wells and of irrigation developments in recent extensions of the oasis lead to two main effects: deepening water tables by overdraft (de Haas 2003) and increasing soil salinization (IMAROM 2001). The latter is always the main risk of

irrigation in drylands. Its prevention requires well designed and maintained drainage systems. The disruption of the cooperative management and shifting to an individualistic competitive one impairs the capacity to deal with the two aforementioned effects because this requires implementing adapted new of common regulations.

Conclusions.

There is not general evidence that emigration is triggered by desertification. In Morocco, the traditional sources of migration are related to lack of life horizons for an increasing population in closed environments with limited resources rather than to the loss of resources by desertification.

The inverse flow of people and remittances in coupled migratory systems may have similar effects at the source and receptor areas, in the sense of increasing desertification risk.

Immigration in recently developed agricultural areas that have not yet build up their own internal cooperative systems to keep sustainability, may impair or delay this process by lowering labour costs, the main component of fixed costs per unit area.

The flow of remittances into a migratory source that has built a complex cooperative system along its history to manage its resources, may cause its loss of sustainability by disrupting its traditional common regulations and causing a shift to competitive patterns in resource use.

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