Research Paper ARTS

Formation and Regression of the Ebro Delta: Ethical Implications of Human Intervention (Tree Cutting and Dam Construction) in the Natural Environment

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ABSTRACT

The processes of formation and regression of the Ebro Delta are in part the result of tree-cutting (15th century) and dam construction (20th century).Both of these human activities and their impact on the natural environment can be evaluated from an ethical perspective.Before doing so, it is clear that there is a need for objective information and a value structure. Once the framework of the relationship between humans and the natural environment has been defined, the concepts of "evaluation of activities with negative effects" and "culpability in the event of omission" are applied in order to make a judgement.Subsequently, the "responsibility for applying corrective measures" and "solidarity" are highlighted.It is then concluded that the restoration of woodlands in the Ebro hydrographical basin, and protection of the Delta to prevent its regression, are essential corrective measures.

KEYWORDS Ethics, Sustainability, Delta, Dam, Environmental Impact

Introduction

During the 15th century, a large part of the tree cover in the Ebro River basin was removed, mainly in the current Monegros Desert, in order to obtain timber to construct boats (Sorribes, 1998; Serra Raventós, 1997). The removal of tree cover was followed by a process of erosion and transportation of soil, which was carried by rainwater to the river, and consequently to the sea.

The natural balance between the dragging capacity of sea currents and the contribution of bedload by the river was broken. Material was soon deposited and, with the passing of time, the Ebro Delta was formed.The area of the Delta became a zone that was valued as a nature reserve and as agricultural land(Ibáñez et al., 1996; Curcó, 2006; Nebra et al., 2011).

In the 20th century, with the construction of major dams such as Mequinenza, Riba-roja and Flix, and as many as two hundred in the whole of the Ebro basin, their respective reservoirs already acted as decanters:sediment from the basin was no longer transported to the Mediterranean coast, but was retained upstream of the dams.

As a result, it returned to a state similar to that of the period prior to the 15th century, which explains the regression of the delta that has been observed in recent years.This phenomenon is in itself much more complex, as other phenomena are superposed (Day et al., 1995), such as subsidence due to the weight of the sediment, elevation of the sea level due to climate change and lowering of flood levels achieved by reservoirs which stop transporting large quantities of sediment on occasions, or which can change the course of the river in an event of just a few hours.

However, contrary to what is stated above, "almost 6000 years ago, there was already a delta, much smaller than the current one, but a delta.[...] The theories on the past of the Delta should be completely revised" (Sorribes, 1998).Indeed, it appears that the regression of the Delta in some areas was already occurring in 1700 (Oresanz, 1998).

Paradigmatically, this phenomenon demonstrates the many consequences of human intervention on the environment. Firstly, it is easy to see the decisive impact this intervention may have.Moreover, the ethical dimension of such intervention, shown by the outcomes of it, cannot be disregarded. Alongside these points, there are other factors, which do not admit unilateral or simplifying evaluations.Thus, it appears that it is necessary to ask ourselves which elements of opinion can and should be considered in order to make ethical assessments of the human impact on the environment.

2. Objectivity of Information and Definition ofValues.

The case of the Ebro Delta brings up two basic aspects that must be considered before making an ethical judgement on any human action.

2.1. The decisive influence of knowledge in ethical judgments

Ignorance of the existence of a previous delta is, technically, partial ignorance of the true origin and formation of the delta.Everything points to the fact that the current delta is more ecologically and environmentally rich than the previous delta. However, the delta that existed at that time was of completely natural origin, whilst the expanded delta owes its greater surface area to man's actions.

Knowledge of the history of the formation of the Delta significantly changes the assessment that can be made of man's intervention.From an engineering perspective, the integration of economic, environmental and social perspectives into decision-making is covered in the literature (Armengou et al., 2012), and they are interrelated.

The debate on sustainability is closely linked to the knowledge we have of the natural environment and the laws governing it.The culture of each person or the education they receive will influence the way in which the information available is evaluated (Li and Fu, 2012). Likewise, it may be difficult to remove the uncertainty in the knowledge (Mosalam et al., 2012), which is connected to the simplification of the situation inherent to any model we make to process it (Odenbaugh, 2008).

2.2. Need to define values and principles

In any case, tree-cutting in the 15th century caused the formation of the current Delta.When we say that the construction of dams has a negative effect, we are indirectly saying that the human intervention of the 15th century has had a positive influence.Yet this is only true if the Delta is valued as something positive.If it is the intactness of nature that is valued, any action is negative.

The reason why the dams constructed in the 20th century and the effects they produce are rejected cannot be based only on respect for the original nature, or on a conservation principle of "non-intervention"; at the same time it is also necessary to pay attention to the ecological, social and economic dimensions of human intervention in the natural environment.

Basically, we are asking ourselves what are the rights and responsibilities of humans with respect to the natural environment (Ramos, 1993):"should it be kept intact?; should it be developed according to models we need to establish?; is it enough to make it habitable?, for us or for future generations too?; can we exploit it as we wish?; should be return it to how it was before our presence?"

To answer these questions, it is not enough to state the obvious; it is necessary to define the values to be respected and the criteria to be used (Whites, 1986; Robert et al., 2005; Mills et al., 2009; Wilding, 2012).The criterion of non-intervention alone can lead to impoverishment of the ecosystem rather than improving its conservation.In the example of the Ebro Delta, tree cutting clearly had a beneficial effect at the time, although the action could have been judged as unnecessary aggression.

Defining values and criteria is not the same as defining models.Models cannot be extrapolated to more than one case. However, adopting a value or criteria such as "respect for the richness of the ecosystem" provides support for ethical judgements.In the case in question, protecting the current environmental variety appears to be more valuable, but this cannot be achieved by stressing the value of non-intervention in nature, as the current existence of such a variety of species in this zone is, precisely, the result of human intervention, together with the geological-hydrological dynamic.On the contrary, the value of the natural richness that exists now, and which is in danger, could be stressed.

This controversy highlights the importance of knowing about the effects that human intervention can generate or has generated.Having such detailed and complete knowledge can shed light on the advisability of an action on the environment.

This judgement will always depend on the definition of values or references, depending on whether priority is given values such as the variety of species, usufruct or management of natural resources by humans or the short or long term.Time and forecasts are a decisive factor, as some actions may appear destructive in the short term, whilst in the long term are not, but it is difficult to make an estimation because the real situation is complex.This is exactly the case for tree-cutting in the delta area in the 15th century.

3. Typologies of the Relationship between Humans and the Environment

What all the problems mentioned have in common is the way in which the relationship between humans and nature is understood.The demands for respect and the urgent need for moderation in exploitation of the natural environment have forced an ethical review of this relationship.Specifically, the rights and responsibilities of humans with respect to nature have been defined in different ways.

There are various currents of thought (ecophilosophies) which are grouped together according to the way they interpret the relationship between humans and the environment.The term ecophilosophy was first used by Arne Naess (1972) and subsequently by other contemporary authors reflecting on the latent philosophies in ecological positions, such as Mele (2001) and Bellver et al. (1997).

There is a wide range of behaviours, and of people's positions towards naturefrom a position of superiority, with extreme anthropocentrism, which considers man to be the centre of nature and justifies exploitative behaviour, to a position of equality or even inferiority, such as is the case of biocentrism, which displaces people from the centre of nature and places them on the same level as other species.An alternative to this behaviour is ecocentrism, in which nature in its entirety is the protagonist.These different perspectives of the same reality generate different ethical positions.The literature on environmental ethics is extensive and it is very difficult to try to classify the different positions.A simple outline is that used by Albareda (2010) or Ballesteros (1995):

- Technocratic anthropocentrism, in which nature is considered as a "generous slave".
- Savagery, where nature is the "unconditional owner of man, and wicked stepmother".
- Personalecologism, which sees man as "thinking humus", as a "dependent being and at the same time guardian of nature".

Various authors argue that personal ecologism is the only sustainable way to coexist with nature (cf. Ballesteros, 1995; Melé, 2009).This ideology advocates that development should be both human and sustainable.Natural resources are to be used with moderation and a sense of responsibility, with a view to the prospering of humans and of future generations. It attempts to understand and respect the dynamic within nature and biodiversity, and it considers that people can only develop in harmony with nature.

4. Dimensions of Sustainability.

A key principle of ethics is sustainability. To understand this principle, it is necessary to look at how it is projected in different dimensions:

a) Social sustainability:human rights, values of justice and equity, respect for ethnic minorities, cultural heritage and gender equality and many others.
b) Environmental or ecological sustainability:water and air quality, caution in exploitation and management of mineral resources, conservation of natural biodiversity (ecological, of species and genetic), climate change mitigation and desertification.
c) Economic sustainability:poverty reduction, rejection of minority and short-term economic benefit in detriment to the common good, or benefit which causes harm to the life, health and holistic development of other people, requirement for honesty and transparency when contracting services, and many others.

Inevitably, the different dimensions of sustainability are interrelated, which requires careful deliberation in human actions concerning the environment.Actions that appear to be small can cause disasters on a large scale.Major disasters such as Bhopal (1984), Chernobyl (1986), Love Canal (1978) or the oil spill in the Gulf of Mexico (2010) were caused by negligence, the consequences of which were difficult to calculate.Obviously, current environmental impacts have a critical effect on the future.

This demonstrates the need to establish criteria or limits for the actions undertaken by humans, as otherwise the planet or a specific zone will become uninhabitable.For these actions to be sustainable, the different dimensions of sustainability (economic, ecological and social) and intergenerational sustainability must be considered at the same time.

4.1. Managing uncertainty

However, it can be deduced from analysis of the Ebro Delta case that the ethical judgement of environmental interven-

tions is extraordinarily complex.One of the biggest difficulties is obtaining and adequately evaluating the information necessary, as well as estimating the possible consequences of these interventions in the future.

There is an ethical duty to have all judgement elements reasonably necessary to act.It is not sufficient to perform an evaluation for the immediate future, but rather there is a moral obligation to find out both the immediate consequences and possible future repercussions.Despite the fact that these predictions cannot be viewed with absolute certainty, they make it possible to estimate the possible damage and benefits.This way of acting is a cautious ethical measure.Environmental practice shows that a lack of caution has caused extensive damage, both to humans (death and illness) and to nature. Intergenerational and international sustainability require the highest level of rigour in decision-making.

Environmental ethics requires a search for the best knowledge and the highest level of certainty.Any negligence when examining all the factors involved, lack of exhaustiveness in investigating possible effects or rushed decision-making are serious failures of responsibility, since the human and environmental damage resulting from intervention in an ecosystem may be irreparable.

The environmental culture developed in recent decades has a significant influence on ethical judgements.An environmental action carried out today does not have the same ethical responsibility, in that there is greater environmental awareness and more resources for estimating the consequences, compared to an equivalent action carried out in the 15th century or in 1950.°° <}0{>The gravity of the effects of deforestation, for example, has gradually become known in detail over the last 20 years (Jahoda and O'Hearn, 1975, Ostrom, 2008).

Along with improved information resources, the contemporary experience of natural disasters with serious human consequences has caused a decisive change in culture, increasing environmental awareness, which forms part of globalisation.The cultural context in which we currently find ourselves makes any negligence in ethical judgements unacceptable and those who must make important decisions should be held liable.Society has expanded its perspectives and requires management of the environment into which sustainability has been integrated (Takahasia and Uitto, 2004).

4.2. Sustainability questioned

The use of the concept of sustainability in different fields and with different meanings is a new phenomenon that is adding uncertainty to the structure of values and knowledge.In marketing, it is used as a lure, to the point that it has caused a certain "eco-fatigue", a term coined by the social psychology and environmental academic Enric Pol(2011).Both the excessive use of the term, and a lack of precision in defining it, have caused a loss of meaning.

For this reason, the concept of sustainability is only an apparent point convergence.In reality, there is no agreement, as not all the dimensions included are always considered, and the same ethical criteria are not always shared.

There is also a lack of knowledge of the reasons why sustainable behaviour is necessary at an individual and collective level. What are the real reasons? What needs to be sustained (Robert et al., 2005)? A vSometimes it is stated in terms of the rights nature itself has, or solidarity with future generations (O'Riordan, 2009), or because there is implicit consensus. In this respect, it is again necessary to define values and make explicit their raison d'être. Otherwise, decision-makers will not be able to work together and aim for sustainability, despite the fact that it is considered to be necessary (Norcia, 2002).

4.3. Nature as a loan to us: a solid substratum

Firstly, we should ask whether environmental sustainability is an asset for humans.This a decisive aspect in any ethical approach, and may be effective motivation for raising awareness of the need to respect nature. It may also assist in education on moderating and restricting actions to exploit natural resources.

Regardless of the subjective reasons each person may have, it is sufficient to consider that the fundamental bases of human life (health, quality of life) are directly dependant on environmental quality.Basic human resources such as water, food, shelter, medicines, clothing and energy sources are directly or indirectly derived from the natural environment.In addition to these needs, there are others that appear less urgent, such as the enjoyment of natural beauty and leisure options.

Furthermore, we defend the view that nature has value in itself, regardless of the benefits to humans.The order of the universe must be respected, because it precedes us and we did not create it.Nature is governed by its own laws.To try to change them supposes arrogance, if not ingenuity; environmental disasters caused by humans show that we must act with caution, and that our management of natural resources has limitations.

It is easy to see nature as a source of resources for humans, but this is not its only dimension or its only source of value; on the contrary, it must be seen as an asset in itself, one which deserves respect.In it we discover an order which preceded us and can be perceived from the molecular level right up to the cosmic level.This harmonious arrangement is manifested in every ecosystem or living being.Every cell, organ or thing has the ideal structure to perform its function, and their interdependence has been demonstrated.

This ecological complexity, or complexity within a living being, is more than the mere sum of its parts.Even apparently useless or harmful elements have a function in the self-regulating dynamic of the ecosystem and its interaction with others. This natural balance therefore constitutes an asset in itself, although we do not always see its meaning, so the order that exists in nature deserves respect.

If we verify that this natural order came before it was known and any interference in it, this respect becomes an ethical imperative.Observing all the resources provided by the planet and the effectiveness of natural ecosystems invites caution. Before changing either the inert environment or the natural biodiversity of ecosystems or species, it is necessary to consider the possible interdependencies between a particular living being and the rest of the ecosystem, and the interactions between ecosystems.

Some sciences, such as thermodynamics, quantum physics or ecology, have highlighted the internal organisational structure of matter and its complexity.This harmony, which brings together the diverse in a stable unit, is the condition that enables life in the universe and makes it a cosmos.The term cosmos indicates the difference between the universe as an ordered reality and chaos.

It is our responsibility to look after and maintain this orderly universe, which is presented to us as a loan not only for the immediate and local beneficiaries, but also for future generations.There is thus a double universality, in time and space:sustainability should be intergenerational and international.

Sandel (2007) uses the term "hyper-parenting" to describe those parents who bring up their children from the earliest age so that during their life they reach an objective about which they have not consulted them, and which the parents associate with success.When considering the protection of nature, or its very design, the term hyper-parenting again comes to mind.We may consider nature as something we possess, or even worse, something we created.Possibly due to a tendency to analyse only the economic and technological aspects, we lose sight of the fact that nature was here before us and is much wiser than us, that it is governed by laws that we can

understand but not create, laws that transcend us.

The smartest attitude man can have towards nature is of wonder and respect from the start.Such an attitude is the result of admiration and has existed since the origins of humanity until the modern age.According to a Cartesian vision, the world is reduced to a mechanical system of fragments without any internal connection, and therefore it can be manipulated arbitrarily.According to Bacon and the mechanist philosophy, nature is simply an object of study and manipulation, without any meaning of its own.Nature is not acknowledged to have its own identity and teleology."And, finally, it can be dominated, modelled, and even completely changed until it is almost recreated by art and human work, exactly the same as for artificial things since, in fact, in artificial things it appears that nature was recreated in a new arrangement of bodies, as if it were a different universe" (Bacon,1612, p. 9-10).

In this mechanistic vision of the natural world, nature is no longer considered as a loan to be used as an exploitable resource according to technical or economic power.By adopting this position, the human being changes from manager to exploiter.

Analysing the geological history of the formation of the Ebro Delta again, it can be seen that some of the effects of the interference in the natural environment are unpredictable. Tree-cutting in the delta basin, which we would today judge as an attack on the environment, has by chance generated a place of extensive biodiversity.However, the major disasters that have occurred in the last fifty years by accident, such as the events in Chernobyl and Bophal, demonstrate that the negative impacts on the environment can have serious sociological and ecological consequences, which constitutes a call for caution.We currently have resources which enable us to estimate the possible consequences of human interference with the environment.

5. Tools provided by ethics.

Through this case, the hypothesis questions whether, in practice, ethics really has something to say:whether or not it is a guide for acting better, acting smarter; whether it helps us, individually, as a society, today and in the future, to be more fulfilled.Throughout this section it will be seen that it does have something to say, and that it provides answers for the whole of the conceptual framework described above.

With regard to the Ebro River Delta, it can be seen that an action (tree-cutting) that was performed without any concern at the time, would be in contradiction with the vision of sustainable development using today's criteria.

Moreover, regardless of the human development it has undoubtedly brought, the construction of dams harms the richness of the Delta:it also contradicts sustainable development.

However, in terms of conservation of the environment, the construction of dams is bringing the Delta towards a state that is closer to that which was "chosen" by nature, without considering human action:a poorer and less diverse state.

The contribution of ethics is undeniable with respect to consideration of aspects which go beyond the economic and technological.However, it is not clear that it sheds light on a problem such as that of the Ebro Delta.

Taken to the extreme, if we were able to demonstrate that a violent action against nature was going to produce beneficial effects for human society today and in the future, would we tolerate it? Or indeed, would it be called for?

Of course, this demonstration should go through all the necessary validation steps:consensus, transparency of information, consideration of all the variables and interdependence between them, cost-benefit analysis, etc.However, this is a discussion of the methodology, but the dilemma is still unresolved.

Once this point is reached, any contribution is focused on the principle of prudence.This leads to the consideration that any effect of loss in the environment is to be understood as a negative effect of the action and, therefore, will be judged with the appropriate ethical tools.At the same time, whilst losses are occurring in the natural environment, the principle of caution does not lead to inaction. The concept of omission (failing to perform a duty), provided by ethics, also forces action.

Therefore, the principles that concur in the problem are as follows:

5.1. Valuation of actions with negative secondary effects

An action, the construction of dams, is causing the regression of the delta:when, in a certain situation, the alternatives are reduced to the dilemma of having to choose between not acting or carrying out an action with a double effect, one good and one bad (in general with good and bad effects), the latter shall be legitimate if, minimising the bad effect as far as possible, the following conditions are fulfilled:1), the purpose of the action is not illegitimate (includes the good effect being immediate and not derived from the bad effect); 2), the goal of the agent is genuine, and 3), there is a just cause to tolerate the bad effect associated with the action (Melé, 1997).

When decisions are made, conflicts of interest frequently appear, as has been described above:development versus sustainability.On many occasions the conflict occurs within the same requirement for sustainability.Gustavsson and Sathre (2006) bring up, but do not resolve, the conflict between harming the landscape (extraction of aggregates) or atmosphere (use of recycled aggregates, with higher consumption of fuel and CO_2 emission than the use of natural aggregates) based on the composition of concrete for construction.A similar dilemma arises concerning the positive and negative effects of dam construction itself, knowing that it is a source of renewable energy (Rosenberg et al., 1995). The destruction of the landscape or possible pollution caused by the reservoir are negative impacts for the environment which, precisely, is protected through the production of renewable energy.

5.2. Culpability in the event of omission

In this case, omission means not acting to mitigate the effects of dam construction:there is culpability if something necessary and possible is omitted deliberately and with full consent, by negligence or other means of imprudence(Melé, 1997).

The specific application of this to the Ebro Delta case can be summarised as follows:

Before man's interference in the basin that pours its waters into the Ebro, a small delta was formed.

In a past era when environmental awareness was very low, a human action (tree-cutting) caused the erosion of the Ebro basin.The sediment transported caused "anti-natural" growth of the Delta, which led to enrichment of the natural environment.

Recent human action (second part of 20th century) had a negative effect on the sediment balance of the delta.Although considered positive in itself (generation of development through dam construction), by causing a loss of natural richness, this action has possible negative secondary effects. Evidently, there are many other secondary effects that fall outside the scope of this study.

Once the negative effect of dam construction was detected, the society which has benefited from them is subject to liability and an obligation to act arises:omission is culpable.It is therefore necessary to act to conserve the natural environment in the Ebro Delta.

5.3. Responsibility to apply corrective measures.
There are two underlying corrective measures in this study:reforestation of the Ebro basin and protection of the Delta.

Forest exploitation should be associated with restoration.In the event that those responsible for dam construction could have predicted regression of the delta, it is an ethical imperative to plan the measures to be taken.Without sufficient measures to mitigate the negative effect on the richness of the delta, the legitimacy of dam construction is doubtful.

To generalise what we have seen with respect to the ethics of actions that generate development of doubtful sustainability, it could be said that any loss in the natural environment resulting from human action should be considered as a negative effect indirectly caused by an action that is assessed as good in itself.

From here, beyond the scope of this study, we could debate the means of assessing the negative effects and, therefore decide on the scope of the corrective measures to be applied.

In many cases, the impact on the environment will be critical and the damage caused cannot be sufficiently mitigated, so consent cannot be given for the "supposedly good" action. In extreme cases, interactions with climate change should be taken into consideration (Huntjens, 2012).

5.4. Solidarity
We have seen that on some occasions the cost of the corrective measures will be so high that a project cannot be considered.For the case of a delta, actions can be extremely complex (Abam, 1993; Zhang, 2010).This concept leads us to the idea of the ethical legitimacy, in developing countries, of considering projects that are inadmissible from the environmental perspective unless there is a very high cost for corrective measures; it will not be possible to pay for these measures.

However, there are countries that are already developed which have "needed" high levels of environmental lack of awareness to reach their current state of development.In this case, legal action could be taken to ensure that the most developed countries pay for the corrective measures of less developed countries.That is, so that the costs of environmental correction of the development of poorer countries are borne by richer countries.

This is "solidarity" between countries or regions.This solidarity is desirable on the basis of the ethics of sustainable development, which is precisely what we are talking about.The same motives that are today leading us to halt the regression of the Ebro Delta cause us to halt the damage to the environment occurring in poorer countries, and this cost must be borne in a spirit of solidarity.We are not talking about a "humanitarian" alternative, but an obligation by the richer countries.It is therefore possible to talk about the culpability by omission of the richer countries which do not "restore" the natural environment with a holistic vision when poorer countries require palliative measures that make their development sustainable.

The requirement for solidarity is not only ethical, but also comes from the economic and political spheres (Biermann, 2007).There are tools to quantify some aspects of the solidarity "owed" through taxes (Hyder, 2008).

There are many other resources provided by ethics to judge situations centred around the life of a river.The concept of environmental flow, which highlights the need to manage conflicts of interest, has not been mentioned:environmental value, electricity exploitation, diversion of drinking and irrigation water, power plant refrigeration, sailing, fishing, tourism, etc. (Armengou, 1999).Ethics gives guidelines for acting correctly when conflicts of interests occur, or for preventing disputes that may occur.

6. Conclusion
Studying the phenomenon of the formation and regression of the Ebro Delta allows us to draw valuable conclusions in the field of the ethics of sustainable development.These conclusions include:

- Objective information is essential to give an ethical assessment of human actions.
- Without a prior definition of values, no ethical assessment can be made.
- The value of "sustainability" is a valid foundation on which to judge human actions concerning the natural environment.
- Ethics provides tools to assess human actions.It is necessary to emphasize the assessment of actions with negative secondary effects, the concept of culpability in the event of omission, responsibility for the application of corrective measures and solidarity.

Apart from shedding light on decision-making that will have an impact on the future, an ethical analysis allows us to identify responsibilities resulting from past actions which generate various obligations:

- Obligation of solidarity from richer countries towards poorer ones.
- Obligation to restore the natural environment when it has been impoverished because of past actions (in the case in question:reforestation of the Ebro River Basin).
- The same restoration obligation when the impoverishment is occurring at the present time.Specifically, obligation to conserve the richness of the Delta, protecting it from regression resultingfrom the reduction in sediment build-up.

REFERENCES

Abam, T. (1993) Bank erosion and protection in the Niger delta. Hydrol. Sci. J. 38 (3), 231–241. | | Albareda, S. (2010) Elementos de convergencia entre el ecofeminismo de Vandana Shiva y las enseñanzas sociales de la Iglesia. Ph.D. thesis, University of Navarra, Pamplona. | | Armengou, J. (editor) (1999) I Congreso sobre los caudales ecológicos, Aproma, Terrassa. | | Armengou, J.; Aguado, A. and Ormazábal, J. (2012) Sistema integrado para toma de decisions en el diseño de estructuras de hormigón. Informes de la Constr. 527 (64), 391–400. | | Bacon, F. (1612) Nueva Atlántida. Akal, Madrid, 2006. Translation by E. García Estébanez. | | Ballesteros, J. (1995) Ecologismo personalista: cuidar la naturaleza, cuidar al hombre. Tecnos, Madrid. | | Bellver, V.; Ballesteros, J. and Adán, J. P. (1997) Sociedad y medio ambiente, pp. 251–269. Trotta, Madrid. | | Biermann, F. (2007) 'Earth system governance' as a crosscutting theme of global changeresearch. Glob. Environ. Change 17, 326–337. | | Curcó, A. (2006) Aiguamolls litorals: el delta de l'Ebre. síntesi del medi físic d'una zona humida litoral. L'Atzavara 14, 55–72. | | Day, J.; Pont, D.; P.F.Hensei and Ibáñez, C. (1995) Impacts of sea-level rise on deltas in the Gulf of Mexico and the Mediterranean: The importance of pulsing events to sustainability. Estuaries 18 (4), 636–647. | | Gustavsson, L. and Sathre, R. (2006) Variability in energy and carbon dioxide balances of wood and concrete building materials. Build.& Environ. 41, 940–951. | | Huntjens, P.; Lebel, L.; Pahl-Wostl, C.; Camkin, J.; Schulze, R. and Kranz, N. (2012) Institutional design propositions for the governance of adaptation to climate change in the water sector. Glob. Environ. Change 22, 67–81. | | Hyder, P. (2008) Recycling revenue from an international carbon tax to fund an integrated investment programme in sustainable energy and poverty reduction. Glob. Environ. Change 18, 521–538. | | Ibáñez, C.; Prat, N. and Canicio, A. (1996) Changes in the hydrology and sediment transport produced by large dams on the lower Ebro river and its estuary. Regul. Rivers: Res.& Manag. 12 (1), 51–62. | | Jahoda, J. and O'Hearn, D. (1975) The reluctant amazon basin. Environ: Sci.& Policy for Sustain. Dev. 17 (7), 16–30. | | Li, J. and Fu, S. (2012) A systematic approach to engineering ethics education. Sci.& Eng. Ethics 18, 339–349. | | Melé, D. (1997) Ética en la dirección de empresas. Ediciones Folio, Barcelona. | | Melé, D. (2009) Business ethics in action: Seeking human excellence in organizations. Macmillan, London. | | Mele, V. (2001) Per un'ecologia personalista tra antropocentrismo ed ecocentrismo. In Correa, J. and Sggreccia, E. (editors) La cultura della vita: fondamenti e dimensioni. Atti della Assemblea della Pontificia Accademia per la Vita, p. 3, Libreria Editrice Vaticana, Città del Vaticano. | | Mills, G.; Austin, S.; Thomson, D. and Devine-Wright, H. (2009) Applying a universal content and structure of values in construction management. J. of Bus. Ethics 90, 473–501. | | Mosalam, K.; Armengou, J.; Lee, H.; Günay, S. and Chiew, S. (2012) Performance-based engineering approach to the best decision for energy-efficient and sustainable building design. In First International Conference on Performance-based and Life-cycle Structural Engineering (PLSE 2012), Hong Kong. | | Nebra, A.; Caiola, N. and Ibáñez, C. (2011) Community structure of benthic macroinvertebrates inhabiting a highly stratified Mediterranean estuary. Scientia Marina 75 (3), 577–584. | | di Norcia, V. (2002) Diverse knowledges and competing interests: An essay on socio-technical problem-solving. Sci.& Eng. Ethics 8, 83–98. | | Odenbaugh, J. (2008) Ecology and the inescapability of values. Sci. & Eng. Ethics 14, 593–596. | | Oresanz, T. (1998) El Delta del Ebro retrocede desde el siglo XVIII. La Vanguardia. | http://hemeroteca.lavanguardia.com/preview/1998/09/26/pagina-36/34605547/pdf.html (on January 13, 2011) | | O'Riordan, T. (2009) On the politics of sustainability a long way ahead: Sustaining europe for a long way ahead: Making long-term sustainable development policies work. Environ: Sci. & Policy for Sustain. Dev. 51 (2), 40–43. | | Ostrom, E. (2008) The challenge of common-pool resources. Environ: Sci. & Policy for Sustain. Dev. 50 (4), 8–21. | | Pol, E. (2011) Tenemos más conocimiento sobre sostenibilidad que nunca, pero lo estamos destrozando todo. Interview with Anna Boluda for Sostenible: Revista de la xarxa de ciutats i pobles cap a la sostenibilitat. | http://www.sostenible.cat/sostenible/web/noticies/sos_noticies_web.php?cod_idioma=2&seccio=4&num_noticia=439534(on January 13, 2011) | | | Ramos, A. (1993) ¿Por qué la conservación de la naturaleza? Welcome speech for the RoyalSpanish Academy of Sciences. Madrid. | | Robert, K.; Parris, T. and Leiserowitz, A. (2005) What is sustainable development? Goals,indicators, values, and practice. Environ: Sci. & Policy for Sustain. Dev.47 (3), 8–21. | | Rosenberg, D.; Bodaly, R. and Usher, P. (1995) Environmental and social impacts of large scale hydroelectric development: who is listening? Glob. Environ. Change 5 (2), 127–148. | | Sandel, M. (2007) Contra la perfección. Marbot ediciones, Barcelona. | | Serra Raventós, J. (1997) El sistema sedimentario del Delta del Ebro. Revista de obras públicas 3386, 15–22. | | Sorribes, V. (1998) El Delta del Ebro tiene una antigüedad de casi 6.000 años. La Vanguardia. | http://hemeroteca.lavanguardia.com/preview/1998/07/06/pagina-27/33848019/pdf.html(on January 13, 2011) | | Takahasia, Y. and Uitto, J. (2004) Evolution of river management in Japan: from focus on economic benefits to a comprehensive view. Glob. Environ. Change 14, 63–70. | | White, G. (1986) Environmental ethics. Environ: Sci. & Policy for Sustain. Dev. 28 (6), 1. | | Wilding, E. (2012) Framing ethical acceptability: A problem with nuclear waste in Canada. Sci. Eng.& Ethics 18, 301–313. | | Zhang, Q.; Xu, C.-Y. and Chen, Y. (2010) Variability of water levels and impacts of streamflow changes and human activity within the Pearl River Delta, China. Hydrol. Sci. J. 55 (4), 512–525. |