

**EARTH SCIENCES AND THE NATURAL HERITAGE CONFERENCE
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Sustaining the use of the earth's resources which includes human society is a fundamental issue if we are to achieve sustainable development.

POPULAR MYTHS

I want to start off with a few popular myths and contrast these with some statements based on our current knowledge.

(1) The earth's natural resources are plentiful

Firstly, it is claimed that the earth's resources are plentiful and therefore it is perfectly legitimate to take away half a mountain in a protected area in Harris or to dam major river systems like the Columbia River with the Grand Coolie Dam or more recent dams for instance on Europe's greatest river system, the Danube.

(2) Nature is resilient to human intervention

Second, it is claimed that nature is resilient to human intervention so that it is perfectly legitimate on Aberdeen Beach to put in massive groyne systems to benefit the beach or to put croynes in rivers which it is claimed have no impact on the river system as they are beneficial in many different ways.

(3) Natural hazard can be mitigated by human activity

Third, it is claimed that natural hazards can be mitigated by human activity. Take, for example, the Island of Hiemey on the south coast of Iceland when in the late 1970s a lava flow was going to cut off the harbour. The engineers got out with bulldozers and hose pipes and stopped it and, as a result, there was a much better harbour for the fishing fleet. Take, for example, the beaches on the coast of Brittany where sand is moved artificially so the tourism resource of that area can be sustained without which there would not be beneficial economic activity.

(4) Natural resources are infinitely renewable.

Fourth, it is claimed that natural resources are infinitely renewable. So that it is perfectly legitimate to put barrages across estuaries as at La Rance in Brittany on the basis that the use of those renewable energies do not have any environmental footprint in any negative sense. And it is claimed that rock particularly at the separating plate margins as at Krafla in the northern part of Iceland, is emerging all the time and will produce a wonderful source of soil for hydroponics and heaters for the gas barbecues that we all like.

I am sure that many people do believe those statements as being quite realistic.

KNOWLEDGE-BASED STATEMENTS

There is another side of the coin I would argue, based on a series of knowledge-based statements.

(1) Rate of depletion of natural resources is greater than the rate of accumulation

The first of these is that the rate of depletion of natural resources is greater than the rate of accumulation. This is a self-evident truth to experts but maybe it is not to people in the world outside. For example, the use of sand, gravel and crushed rock in Scotland shows continuing increase whereas the rate of production of this material is very slow. Similarly, with hydrocarbons the rate of use is increasing whereas there is a progressive decline in the level of proven resources.

(2) Critical natural resources are being lost through misuse

The second knowledge-based statement is that critical natural resources are being lost through misuse by human activity. There are many examples of this close to home. For instance, in Fife there is sheet erosion of friable soils in the winter period of the year exacerbated by the Common Agricultural Policy which persuades farmers to plant their crops in autumn, and therefore disturb the soil and remove the stubble. There are also the effects of longer-term misuse. An interesting combination of natural and human activity is found near Hecla in Southern Iceland with both the effect of dust from the volcanic eruptions and over-grazing causing removal of vegetation and the development of very extensive erosion fronts which are very difficult to stabilise.

(3) Rate of natural changes are variable and unpredictable

The third knowledge-based statement, which I hope we would all recognise, is that rates of natural changes are changeable and unpredictable. An obvious example is the graph of temperature change for the Quaternary period. Most of us of my age were taught that the Quaternary period has five cold periods and some intervening warm periods. We now know that this is not the case. The rate of change and the scale of change is much more significant than we had ever imagined and it is very difficult sometimes, however, to get this point over to the general public. Slightly more prosaically, perhaps, are the changes that we can observe on the ground, for instance, at the mouth of the Spey which experiences tremendous variability over a very short period of time.

(4) Landscapes and landforms are sensitive to change

Finally, landscapes and landforms are highly sensitive to change. Over the last 20 years geomorphologists, particularly, have been developing the concept of landscape sensitivity, so very delicate hydromorphological systems like the Flow Country in Caithness are destroyed in places by the planting of trees, usually trees that are not going to grow and not going to be productive unfortunately. Furthermore the disturbance of these delicate systems has also released carbon and methane into the atmosphere to a much greater extent than ever the trees could capture. There are also, for example, very delicate systems on some of our slopes such as

the Trotternish Ridge in NE Skye perhaps the most active of slopes in the whole of Scotland, partly a result of the type of material, partly as a result of the slope angle, partly perhaps as a result of weather changes but also partly because of grazing pressures. Trying to disentangle these various activities there is something that we are studying at the moment with NLURI.

So I hope that you will understand the difference between those statements that I regard as popular myths and those that are based on knowledge which is familiar to us. The conclusion I draw is a very simple and very obvious one. We need to get over the messages about our knowledge of the importance of natural systems and of the processes and functions which they perform to decision-makers and, in particular to their advisers, and therefore use our scientific knowledge more effectively to inform decision-making.

SUSTAINABLE DEVELOPMENT

How do these thoughts connect to the issue that has not been mentioned very much at this conference: sustainable development? We have heard a lot about sustaining resources and sustainable natural systems but we need to connect that to the other two legs of the sustainable development trilogy: economic prosperity and social well-being. We cannot ignore these, as if we do then we do not live in the real world. Unfortunately, we have economists arguing about sustainable tourism, we have politicians arguing about sustainable economies. We need to make sure that a sustainable environment is included. By this I mean sustainable environmental systems and functions and not just the static resources themselves.

I like to feel that we might be able to share a vision for the future which I describe as follows: a world where, first, human society and its natural environment are accepted to be inter-dependent. If we feel that we can study natural systems and ignore the human element, then we don't live in the real world and, therefore, the second element is that people are an intrinsic part of the environment. Third, and related to this, is that the environment is recognised as a capital asset for society. And, fourth, and this is the crucial one in the context of this conference, is that we can use the environment for human benefit but with a number of provisos. These provisos are borne out of our scientific knowledge and understanding and its articulation to other people: we use these resources within their carrying capacity, that undue risks are not taken and that the functioning of natural systems is not significantly impaired.

Now, if I try to put these sort of messages over to decision-makers, then I am sure that they will struggle a little to understand. So reflecting a little further and looking at the literature, I am going to suggest that we should have some **guiding principles** and also some **operating principles for the sustainable use of the earth's resources**. I have dug a little bit into the literature and I have examined Brunsdén's Ten Commandments of Geomorphology, the ten principles of ecosystem management which were published earlier this year by Ed Maltby and Martin Holdgate and others, together with work we have done ourselves in SNH: our five principles of sustainable development and some limited thinking that I have done myself.

GUIDING PRINCIPLES FOR SUSTAINING EARTH'S RESOURCES

I should warn you that the guiding principles are not earth-shattering at all, but maybe there is nothing wrong with them being simple and obvious from our viewpoint in that we would be able to accept and to articulate them to other people.

First, **natural change is inevitable**: Nature is not static, there are major drivers: tectonic change, climatic change and the consequences which they have, for instance, for sea level change and for hydrological systems. The rate and scale and timing of change is not necessarily predictable because we know that there are a lot of non-linear effects and also a great many threshold effects. Neither is it easy to predict an end state and certainly not a stable state, given the level of knowledge we now have. It is clear, therefore, that it is usually impossible to turn the clock back when seeking to devise any intervention strategies.

Second, to work with **natural functions and processes**. This is another self-evident truth but too often we see examples of people working against them. It is quite amazing if you drive north from Edinburgh, for instance, over the Forth Bridge and within the next mile there are two excellent examples of working against nature where we have a slope that has been slipping for the last 25 years because engineers have not got the geo-technics right I should say, and the slope on the right hand side where engineers building the railway did manage to use the right techniques and get the right angle but the road builders got it entirely wrong and rocks keep falling off. We do not look often enough at natural systems and how they operate when seeking using them to our benefit. So all of our experience shows that interventions which seek to work with natural systems is the best way to go. This is best exemplified, for instance, in the work on sedimentary coastal cells and in river basins. If we fail to take those messages, then there will be unpredicted consequences within the system.

Third, **manage natural systems within the limits of their capacity**. I am sure you are familiar with the concept of thresholds where a major event overwhelms the capacity of one oscillating system and causes it to into a different one and then it settles down within various limiting thresholds. Unless we can recognise those thresholds, then it is extremely difficult to give sound advice. The same goes for other concepts in earth sciences such as carrying capacity.

Fourth, I would argue extremely strongly that we **should manage natural systems in a spatially integrated manner**. Too often we talk about river systems and we forget slope systems or we talk about mountain systems as if they are separate from water sheds and the upper part of river basins. We need to examine our approach within a spatial framework and at the appropriate scale. A coastal cell, a hydromorphological system, a drainage basin, a mountain system are obvious examples. Integrated planning approaches can help us to make sure that in nature we are seeing the connections and looking at the impacts of actual and potential human activity. SNH is itself doing a lot of work on this to try and make sure that we put the pieces together in our own activity through our Natural Heritage Zones Programme.

Fifth, **use non-renewable global resources wisely and sparingly at a rate which does not restrict future options.** This is not a counsel for saying we should stop using non-renewable resources, that is quite out of the question in our society whether we like it or not. The essential point is to try and influence the rate of resource depletion. It is interesting that in hydrocarbon policy in the United Kingdom in the 1970s there were great debates about depletion policy but the government of the day decided not to have one. Perhaps the reason was that more reserves were being discovered so there was no need to bother.

Sixth, **use renewable resources within their regeneration capacity.** There is a great deal of use of sands and gravels which are renewable but in slow timescales. Similarly, for soils, peat and water but frequently the use that we put them to is much greater than the speed of their regeneration. If we wish to have access to these resources in a state where they can still function effectively then we must be cautious in the rate at which we use them and the type of use to which they are put.

OPERATING PRINCIPLES

There are a number of other, what I call perhaps more prosaically operating principles and I will mention these very briefly indeed. Surely if we are going to help decision-makers and their advisers then we should first seek ways of **improving the understanding of decision-makers.** Second, we should **use our scientific knowledge** much more than we do **to inform decision-making.** Meetings like this sometimes worry me because we are all talking to each other, we understand the language, but how many people in here are really the decision-makers that are working with MSPs? Also, whilst I applaud the fact that we will have these proceedings, as with previous SNH conferences, in a published volume, should we not be looking for different outputs from this meeting which will be much more accessible to decision-makers and their advisers to get over some of the important. Third, in our work we do need to recognise that we do live in human society and we have **to recognise human needs and aspirations.** Fourth, we should **adopt the precautionary principle** which is not the do not do anything, it is actually what I call judicious risk-taking. SNH has developed a step by step approach to the precautionary principle which a decision tree using that approach which leads to outcomes of 'no' or 'yes' or 'yes with adaptations'. This way we can seek to design intervention to work with rather than against natural systems. Sixth, we should **recognise the link between earth processes and biodiversity.** And finally, we should make sure that we do have **indicators which measure natural systems and processes** in a way which allows the material to be used to inform better future decisions.

CONCLUSION

The state of our knowledge of processes and functions of the earth has increased enormously. However, there is still a major gap in understanding by all advisers and decision-makers. It is vitally important, therefore, for such scientific knowledge translated and interpreted to improve the decision-making process. As a result we should be in a better position to safeguard natural functions and processes and, therefore, earth's resources as a whole. The outputs from this conference should, therefore, in addition to book, be in a form accessible to a wider audience.