BOX 2H
FROM CONCEPT TO INDICATOR: DIMENSIONS EXPRESSED AS VECTORS

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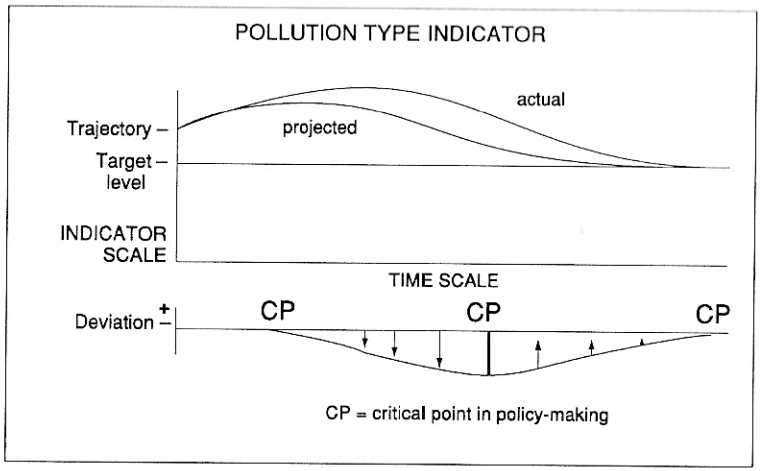
A vector is something that has both magnitude and direction. Vectors are often used in oceanography, meteorology and fluid dynamics to describe winds and currents, and may be shown on charts as arrows with the size or length giving magnitude and the orientation giving direction[2]. The usefulness of indicators expressed as vectors is that they can be used to show relationships or flows in space as well as trends over time, both of which are important to defining sustainability.

Vector indicators which give the direction of movement towards or away from a goal, and the speed of that movement, can provide one way to express the concept of sustainability without falling into value judgements about development. Such indicators will allow each country to define for itself how it imagines its ideal future sustainable society (in itself an instructive exercise), and then to report, for each indicator, whether it is making progress towards its own goal, and at what rate. For instance, a country could determine what would be its optimal human population size, calculate the population growth curve necessary to stabilize numbers at that size, and then use as an indicator a vector measuring the size and direction of the deviation of its actual population curve in order to reach its own target. A policy maker could thus see immediately whether the trend is going in the right direction, and how many years it will take to achieve the desired result. The goals or targets so set at the national level will need to be flexible and subject to change as technological possibilities, new discoveries and social visions change. For a dynamic process like the sustainability of development, it is normal to have a moving target. Since sustainability is itself difficult to define, and most current indicators measure negative factors or pressures preventing sustainability, vector measures allow countries to report, for instance, the progress they are making in reducing damaging activities, even if they have not yet defined clear goals for sustainability.

Vector indicators and their associated targets lend themselves to graphic representations that can make it easier to communicate the idea of trends towards sustainability over time. Two examples can show how this is done for a population-type indicator and a pollution-type indicator (Figure 1, from Dahl 1996a). The former shows how one might indicate the process of bringing an excessive population back down to a sustainable target level. The second shows a set of step-wise reductions in the limits set for a pollutant.



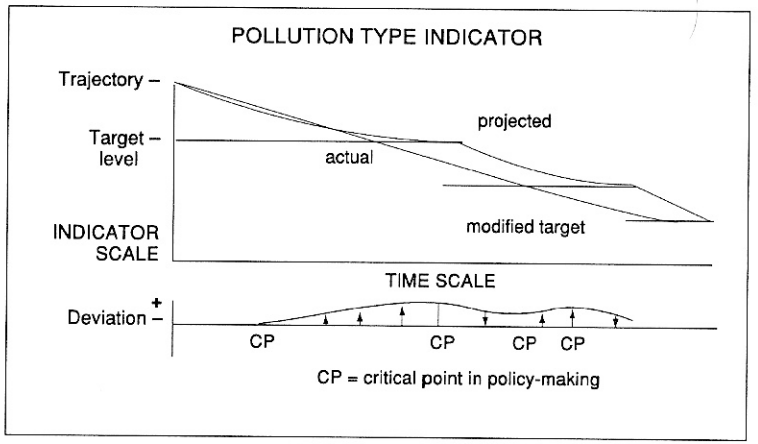


Figure 1 Trajectories to sustainability targets

First, the particular target that has been set locally for the indicator should be combined with a projected trajectory of the indicator to reach the target at the planned time. If this trajectory to sustainability is agreed as part of the planning process, it will help decision-makers to visualize the commitment they are making and the effort required to achieve their goal. It will then be possible to plot over time the actual situation or location of the indicator relative to the target level or trajectory set by policy. The deviation between the projected and actual trajectories for the indicator has particular policy significance. This can be a deviation both in the value of the indicator (above or below the target) and it its direction, that is

whether it is approaching or moving away from the projected path to the target, and at what speed. It is the direction and speed of the vector indicator, as well as its location relative to the target, that really begin to define sustainability as a dynamic concept. The aspect which may be of greatest interest to policy makers is the second order vector or indicator of change which can be shown clearly by plotting the deviation on a separate graph. This is simply the measure of how the trend in the vector indicator is changing (slowing down, speeding up, changing direction) between measurements. It is the changes in direction of this indicator that show the critical points in policy-making. This can be used as a response effectiveness indicator, since it is a measure of the effectiveness of whatever actions have been taken, and shows quickly whether the management actions are sufficient or whether further effort is required.

In the first of the hypothetical examples shown in Figure 1, the actual population level starts to overshoot the projected level at the first critical point, signalling the need for action. At the second critical point it begins to curve back towards the projected desirable level, showing that the action taken was effective. At the third critical point the target is reached and the curve changes to a stable level. For the pollutant type indicator, the planners projected a trajectory in the level of the pollutant joining the first target level set by regulation. At that point a new lower target is set, the level is predicted to descend to the new target, and a third target is adopted to bring pollution down further. The actual curve, however, shows the pollutant level dropping more rapidly than expected, below the targets, with four critical points at which the two trajectories diverge, converge, diverge and converge again. The implication of such an example might be that pressures, other than the target levels set by regulations, such as changing technologies or economic factors, are driving pollutant releases down faster than predicted regardless of the regulated levels. These examples illustrate how vector indicators can be used to give policy relevance to measurements.

NOTES

[1] The views expressed are the author's own and do not necessarily reflect those of the United Nations.

[2] This usage of the term 'vector' differs from that of Gallopín (1996) who gives it in a more general sense of any measure combining two dimensions, not necessarily including direction.

REFERENCES

Dahl, Arthur Lyon (1996a) Measuring the unmeasurable. *Our Planet* 8(1):29-33.

Gallopín, Gilberto C. (1996) Environmental and sustainability indicators and the concept of situational indicators. A systems approach. *Environmental Modelling and Assessment* (in press).