Hydrology and Earth System Sciences Discussions

Interactive comment on "HESS Opinions "Climate, hydrology, energy, water: recognizing uncertainty and seeking sustainability"" by D. Koutsoyiannis et al.

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APPENDIX TO THE COMMENT AC S1761: "WHICH BINARY WORLD VIEW?"

Quotations from Popper (Quantum Theory and the Schism in Physics, Unwin Hyman, 1982)

"Let us begin by visualizing our changing world, as it changes its state from instant to instant. The states that belong to consecutive instants are, in some way or other, closely connected. This is why our world exhibits some degree of order rather than complete disorder; why it is a cosmos rather than a chaos. But we will visualize the connection between the instantaneous states not as a deterministic connection, but as

something in between a deterministic block universe and chaos. In order to get this point a little clearer, let us imagine that we have attached a film strip to a certain given instantaneous state of the world, that is, to some given 'time-slice' of the world, and that we use this film strip to represent all the past and future time-slices of the world, as well as we can represent them. We will assume, as a first step or first approximation, that the film strip which we have attached to the given time-slice is a Laplacean or deterministic film strip, or in other words, that it represents a deterministic block universe – the one which is determined by the given instantaneous state or time-slice; for we know that one instantaneous state or time-slice is sufficient, according to Laplace, to determine all the past and future states or time-slices of a deterministic universe. (p. 178).

"Now we turn for a moment from the classical extreme to the other extreme – to the assumption that the world is completely chaotic; and we try to attach another sequence of imaginary film strips to the sequence of the real time-slices, representing this assumption. How could we do it? The assumption that the world is chaotic clearly does not allow us to make any prediction. Consequently the film strips will be void of any definite information. They will leave open all possibilities, they will permit any state to be followed by any other (logically) possible state. Assuming that we know somehow what would be a (logically) 'possible state' of the world, each of our film strips would have to consist of stills, incorporating a catalogue of all possible states of the world, and attributing equal weight (or probability) to each possibility. Consequently all the film strips attached to the various time-slices would be exactly alike (as they would be in a determinist world); moreover, all the stills of each of the films would be exactly alike, as they would be if we were living in a world without any change in time: for there is only one complete catalogue of possibilities." (pp. 179-180).

"What I have attempted to convey with the help of my picture is just this: that indeterminism forces us to adopt the view that there can be no theory which completely predetermines all events ahead; that therefore each time-slice yields its own predictive

film which, however, soon loses its usefulness; that later and later time-slices give us a better and better idea of an event ahead of them all; and that we therefore have to try, if we want a detailed and reliable prediction, to obtain a description of a time-slice (or part of it) of a recent date – as recent as possible. All this is very simple; and it strikes me, intuitively, as more natural and familiar than the classical Laplacean dream of unlimited predictability. It is, in a way, too simple; and I shall soon ... enrich my picture by replacing my deterministic or classical film strips by others: by film strips that describe propensities." (pp. 182-183).

"The solution of this problem (suggested by quantum theory) is this: the new type of film strip will consist, like the chaotic type, of catalogues of possibilities; but to each of these possibilities will be ascribed a probabilistic measure or 'weight'. This turns the catalogue of possibilities into a probabilistic distribution – a distribution of propensities. ... It will be remembered that in one of the two extreme cases, – in the case of complete chaos – we found that all the film strips became identical, each being simply a repetition of the same complete catalogue of all possibilities. But once we ascribe measures or 'weights' to the possibilities, there will be an immense number of different complete catalogues, each with a different distribution of weights over the various possibilities. It is further clear that if we consider one of these weighted catalogues that replaces, say, a classical still not far removed in time from the real time-slice to which the film is attached, then it will have to give most of the weight to those of the possible states which are very similar to the state which the classical theory predicts; consequently, it will give hardly any weight to most of the other states. But this implies that, in any of the films, the distribution of weights in consecutive 'stills' (that is, catalogues) will be closely connected; or that the distribution of weights in one moment will determine the distribution of weights in the next moment. As a consequence, the succession of stills (of weighted catalogues) in each film will be of a deterministic character – very much like the succession of stills in the deterministic or classical film strips which we considered first .... The difference will be this: laws of a determinist character (although not necessarily identical with the classical laws) now connect catalogues of the 'weights' of all possible

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states of the world, while before, the classical laws connected a representation of one state of the world with that of another state of the world." (pp. 186-187).

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