Ecological Complexities and Environmental Uncertainties: The Statistical Challenges or Is Optimal Ambiguity Zero?[1]

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A man once asked a camel whether he preferred going uphill or downhill.
The camel said: 'What is important to me is not the uphill or the downhill-it is the load!'

Idries Shah, The Way of Sufi, 1968[2]

One of the reasons why metaphorical communications has low entropy is because tremendous amount of complexity is encapsuled in a metaphor. It is true that any metaphor is ambiguous and to that extent there is a possibility of some variation in the meaning. However, the variance in the meaning is of very small order to ensure the consistency over time and space. Pattern analysis apparently poses same challenge. My first submission is that we can learn to define the problem of dealing with ecological complexity and environmental uncertainty by unravelling the process different cultures use to codify variation in natural processes. My fear is that in our anxiety to make certain concepts or categories very pure, i.e., devoid of much variance, we lose the capacity to link such concepts with other associated sources of variance and therefore miss the wood for the trees.

My second submission is that statistical challenge in the areas of high risk environments is obviously of a different kind and therefore we may have to evolve new heuristics of approximation which will prevent us from getting too close to the real numbers. And perhaps therefore make the pattern apparent. Finally, I am sharing my ignorance by suggesting certain areas in which I find people involved very intimately at grassroots level and without much success in dealing with the underlying risk and uncertainty. I will draw some cues from the indigenous knowledge of sampling and pattern analysis without hypothesizing how statisticians can deal with it. Not because I do not want to do it but because it is simply beyond my competence. To that extent I am trying to be consistent with my submission of maintaining optimal ambiguity not being zero.

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[1] Talk delivered at ISI, Calcutta in a national seminar on Survey Research, Feb 7-8, 1997
[2] Idries Shah, 1968 The Way of Sufi, New York: E P Dutton

Part One : Boundaries of Uncertainty: How much to define?

In linguistics, Chomsky and Campbell have argued that the cross cultural variability underlying basic rules is much lesser than the one underlying the language itself. Halliday, Mclntosh and Strevens (1964:23)[3] state what is obvious, `since the purpose of the theory is to account for the largest number of events as simply as possible, this means that the theory of grammar is more powerful than the theory of lexis. So in making a description of any language we try to bring out as much as we can within the framework of grammar'.

Apparently the linguists use Beysian analysis while choosing elements of structure within a verbal group. In Russian the authors observe, `you must choose between perfective and imperfective, in Chinese you first choose whether to choose or not'. Because Chinese have apart from these two a third aspect of neutrality. European languages tend not to have these neutral terms whereas several east Asian languages reportedly do.

When we analyse language, how do we deal with variance:"variation is both an index of function and an index of the different ways in which accounts can be manufactured" (Wetherell and Potter, 1988:171)[4]. Let us take two analogies from nature to take this issue forward. Konrad Lorenz has influenced a whole generation of ethologists but also those who have some thing to do with reason and its evolution in our minds (some thing most of us claim is our business!). Riedl, drawing upon his work suggests two inferences from the problem of pattern recognition in uncertain world, (a) after observing the angle of branches, fins, feathers and so on, besides a skirt of a women, cover of a microscope, bell flower, bell of a church, he wonders why nature seems to prefer the shape of normal curve. And he then infers: nature is very parsimonious. It has very few designs and it plays with them all the time. (b) while interpreting the probability of coincidences , he observes that tick require blood of mammal for its survival. Consequently ticks have a job to do. They have to find mammals among all natural objects. They need a heuristic which is simple and reliable. It is supposed to have an inheritable program which makes it stop on smelling butyric acid and "allows it to drop from branches and on touching some object at 37 degree centigrade, to pierce it. This "definition" of the mammal in the "world view" of the tick cannot be surpassed either in simplicity or in certainty of success. Error is almost is excluded (Riedl, 1981, 1984:30)[5].

What do Eskimos do when they have such large number of words for snow and coastal fishermen for waves? Is it true that the variance in the same phenomenon is perceived *and patterned* by people dependent for survival on a natural resource differently than say the people whose survival does not depend on such a resource. Why should dependence

[3] M.A.Halliday, Angus McIntosh and Peter Strevens, "The Linguistic Sciences and Language Teaching, 1964, London, Longman Group Limited

[4] Margret Wetherell and Jonathan Potter , 1988, Discourse analysis and the identification of interpretative repertoires in Charles Antaki (Ed.) Analysing Every Day Explanation, London: Sage Pub, 168-183

[5] Rupert Riedl, Biology of Knowledge: The Evolutionary Basis of Reason, Chichester: John Wiley and Sons

on a resource make patterns visible ? Assuming that each word is a concept and a category and this patterns are coded in words of a language. Does it mean that Statisticians can learn some thing about petterning from the people surviving on the margin of society ? Are we then suggesting that language of the underclass may provide some clue about the way to understand uncertainty in a phenomenon and deal with it? Not necessarily. The elite may have an equally rich taxonomy of wines, tea or canines just as poor peasants may have of clouds, soils, and bullocks. The issue thus is to learn from the heuristics of those who observe a phenomena intensely and reduce the underlying complexity through some simple rules.

Part Two: How can we capture simplicity underlying a complex ecological phenomenon? Can methods be a problem?

Another Sufi tale helps us get into the heart of the problem:

> *Someone told Uwais el-Qarni that a certain dervish sat on a tomb,*
> *dressed in a shroud and weeping.*
> *Qarni said:*
> *'Tell him that the method has become an idol; he must transcend the practice,*
> *for it is an obstacle.'*

Statistical tools for dealing with ecological complexity have to deal with what I call Type one and Type two blinkers:

Type one blinker prevents us from realizing the problem of knowing too much about a sub system could be a reason for our not knowing even moderately about the other parts of systems. The disciplinary boundaries are a logical result.

Type two blinker prevents us from understanding any one part even reasonably well because of our obsession to understand all the linkages in the system.

Perhaps we have to devise tools which can overcome both the customs and generate reasonable degree of assurance about future outcome. Some of the illustrative areas where we need to discover better tools, perspectives and heuristics are:

(a) On farm research in problems soils and rain fed regions.

It is well known that coefficient of variation is generally more than 30 per cent in replicated trials in these regions. There are several peculiar problems which arise in different kinds of conditions. For instance salinity and alkalinity patches arise in a seemingly random manner. However, the sub soil drainage which influences the pattern of patches may not be all that random.

(b) Variability in mono cultures

For a long time, it has been assumed that the well-endowed regions having mono culture crop cultivation deal with more or less uniform condition. To some extent in the early years of green revolution, the uniformity in soil and water conditions was evident. Of late, the variability in micro environment has generated a mosaic of conditions for pests, diseases and soil mineral profiles. Tools to capture this kind of variability with overlay of uniformity (of soil, drainage or other socio cultural conditions) will have to deal with second order and third order variations.

(c) Indigenous Soil and Water Management : Designing variable structures

Given undulated catchments, the hydraulic pressure on the bund is likely to be uneven and therefore people have often evolved appropriately variable structures. The dynamics of this variability is still poorly understood despite availability of GIS and other softwares. The problem becomes more complex in rainfed regions where sub soil permeability may itself be variable.

Conceptually all the three cases described above deal with multi layer phenomena in which each layer follows different rules of variability. Different layers interact among themselves and with the upstream and down stream interactions in unpredictable manner. Once the variability in grass and tree cover is super imposed, the complexity increases further. The challenge is to simplify the complexity without losing too much of information and control.

(d) Pollution effects on terrestrial, aquatic and aerial diversity

The complexity of molecular drift, its interactions with other molecules in nature and consequent change in the drift, flow, assimilation and or precipitation is quite high. The modelling of this complexity will become very crucial for survival during accidents, extra ordinary climatic changes and other human use factors.

(e) Biotechnology and predictable response

The variability in the tissue cultured plants years ago warned the scientists of the inherent danger in assuming uniformity when there was none. This raises another kind of problems which is going to become more and more tough. Lot of work in embryology has relevance for this kind of problem.

(f) Growth dynamics of multi species habitats

Forests with different species of plants, water bodies with different organisms and aquatic animals and other diverse habitats pose problem of estimating growth or decay in a predictable manner. The ecological problems become more complex when our

understanding of inter species interactions does not grow at the pace at which the complexity grows.

(g) Plant variety regulations

One of the requirement of the future plant variety protection regime will be to establish distinctiveness, uniformity and stability (DUS) for locally developed varieties as well as for scientifically developed varieties. If farmer's selection has to be accepted and if a variety so selected shows variability over a short time and space, appropriate models for establishing stability over long time periods and over large distances (through pooled variance) will have to be developed.

(h) Sampling criteria for estimating productivity of non cultivated land and non exploited water bodies.

Large number of poor peoples in our country derive their subsistence through the use of open access or common property resources. And yet there is no estimation system of the productivity of the resources. Even from the point of view of eco system monitoring, such a strategy is certainly called for.

Part Three : Learning from the survival ethic

What I have tried to argue this paper is a three pronged approach to deal with ecological complexity and environmental uncertainty through statistical analysis, modelling or heuristic.

(a) Recognizing the patterning behaviour of local communities and experts dealing with variability in nature to identify new heuristics

(b)Understanding the challenge inherent in the complex ecological processes and

(c) Appreciating the need for optimal ambiguity

It is obvious that those who have to survive with minimum information under highest risk will have to evolve thumb rules generating efficiency in information processing. Can the efficiency of the weakest be a means to generate future options?

It is obvious that poor do not always optimally survive. Therefore their heuristic will have to be matched with other tools and underlying enigmas.