

Global Crises from the Perspective of Complex Adaptive Systems

Mathematics of Global Problems:

Recently the whole world has faced a global food crisis (GFC). We propose to call such a problem an “emergent problem”. An emergent problem is characterized by:

- i) It has several reasons not just one.
- ii) It cannot be solved locally (e.g., by one country) hence “collective efforts” are required.
- iii) It needs a long time to be solved, hence evolutions in strategies and conditions have to be taken into consideration.

There are several problems that can be called emergent, e.g., GFC, climate change, water shortage problem, and global endemic diseases such as tuberculosis (TB). Such problems require that their mathematical models should have the following properties [2, 3, 6, 7]:

- i) Models and optimization should be stochastic.
- ii) Models should contain several time scales.
- iii) Models should be non-autonomous.
- iv) Control theory results based on short time data should not be applied on long time scale.

It is important to notice that we are not attempting long range predictions since it is known that these phenomena are chaotic. But what we are trying is to keep the system within certain limits (thresholds) to avoid crisis. We think that, despite chaos, this may be possible.

Some Guidelines for Local Governments:

Human societies are complex adaptive systems (CAS) which are known to be open [1], and optimization of such systems is multi-objective. This implies the following [4]:

- i) Complete control of CAS is impossible. Hence the decisions should instead be guidelines. Detailed plans should be left to those executing them.
- ii) Expect some failures. Hence continuous revision and updating are required.
- iii) There is no single solution but multi-solutions that accommodate the different contradictory objectives.
- iv) Diversity should be preserved and encouraged.
- v) Transparency and trust have to exist.

vi) Decisions can result only after serious consultations with those executing them and those affected by them (bottom-up approach).

vii) Deserved decentralization should be encouraged.

Comments and Conclusions:

From the above we have the following comments:

- Collective efforts needed to solve emergent problems require large scale cooperation (c.f., prisoner’s dilemma game). However it is known that for such cooperation to exist a feeling of imminent danger has to exist [5]. Therefore early preparations to deal with such problems are not expected to be as efficient as should be. This is particularly true for the expected water shortage problem, which is acute at certain places and unseen in other ones.

- The expected evolution of GFC is that countries will attempt to increase their production but at the same time increase their reserves. Moreover the feeding behavior of China and India populations is not likely to change. Hence a quick solution of this problem is not expected.

- The bottom-up approach is highly efficient in finding practical solutions and in making people more prepared to share the burden of the problems. But it requires a regime that has the trust of its people, a property that is rare in many third world countries.

We conclude: emergent problems, “messes”, happen and will continue to happen. CAS is one of the approaches to attenuate their effects and make us better prepared for them.

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