Some Thoughts About Mathematical Biology: Phenomena in Nature and Society for Modelling

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Introduction-01/03

- Introduction
- All species (living or nonliving including humans) on this planet earth, their functions, their interactions among themselves, with their environment in the habitat and outside their habitat form a part of Biology. This of course includes all Natural as well as Social phenomena on this planet. Biology, when studied using Mathematics is known as Mathematical Biology.

Introduction-02/03

- Nature is highly complex. Society is equally complex as the human mind is involved which is highly dynamic. Mathematical modeling is a very important tool to predict the behaviour of various phenomena in Nature and Society. It can predict behaviour of such systems which cannot be experimented upon. According to the famous mathematician Ramanujam“ An equation for me has no meaning until it represents the thought of God” That thought, is Nature and Society.

Introduction-03/03

- So we must focus our research to understand Nature and try to solve social problems relevant to survival of species including human beings, plants, animals, etc.

- Real modeling research can be conducted if your mind is on fire for new discovery without attachment and renunciation of the ego.

- In the following let me mention some phenomena in nature and society which require mathematical modeling
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Carrying Capacity of the Earth -01/04

- Human population will reach 10 billion in a few decades. We not only have to feed these people but also provide facilities for education, health, clean water, housing etc,. Since our planet is limited, how to increase its carrying capacity..
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Carrying Capacity of the Earth -02/04

- **Land for Agriculture and Other Resources.**
- One way to do this is to go in for multilayer cropping. This can be easily done even in deserts areas by growing crops where creepers are involved, such as grapes. Also, we can use the unspoilt terrain of rivers in the summer and winter and winter seasons, the time when rivers become very narrow leaving aside fertile soil where vegetables of all kinds can be grown.
- Roof of houses can be used for of farming of vegetables

Carrying Capacity of the Earth -03/04

- **Housing:**
- Underground housing may be planned in deserts areas as well as in hilly areas (in the form of caves).
- **Education and Health**
- There should free internet faculty for education and health. We should have internet Universities and heath care centres. See my website. www.iiuresearchst.org
- Underground housing may be planned in deserts areas as well as in hilly areas (in the form of covered houses).

Carrying Capacity of the Earth -04/04

- **Water:**

- In India during monsoon lots of fresh water goes waste as we do not have adequate facilities for storage. On way to store it could be by making reservoirs all over the country. Also, the rivers can be joined.
- In a desert state like Rajasthan, during monsoon, we are witnessing floods. By constructing a large cemented reservoir new concept of ecology can be used to store water in the reservoir.
- We can also desalinate sea water by using ecological methods which are much cheaper for details.
- Se the following paper,
- J B Shukla, Rashmi Singh ,Ashish Goyal and A.K Misra, Modeling the desalination of saline water by using bacteria and marsh plants
- Desalination ,, Vol 277, pp 113-120 ,2011.

Darwin's Theory Of Evolution, Wild Life Protection And Biodiversity-01/03

- According to Darwin, in a given closed environment (say an isolated island) only the fittest species will survive and eventually the weaker species will be eliminated by the stronger species one- by-one.
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Darwin's Theory Of Evolution, Wild Life Protection And Biodiversity-02/03

- This preposition is true and valid only for closed environment .If the species has a chance for convective or diffusive migration all species can survive if all other facilities are available for their survival.
- We have models which can prove this concept in an open environment
- See the following paper
- J.B Shukla and S. Verma, Effects of convective and dispersive interactions on the stability of two species systems,
- Bull. Math. Biology, Vol 43, No 5, pp 593-610, 1981.
- J.B Shukla and V.P Shukla, Multispecies food webs with diffusion, J.Math Biology, Vol 13, pp 339-344, ,1982.

Darwin's Theory Of Evolution, Wild Life Protection And Biodiversity-03/03

- An unprecedented rate of deforestation is taking place not only in India but also all over the world. It affects not only tribal population living in the forest but the entire flora, fauna and wildlife in the forest. Because of deforestation, the carrying capacity of the forest decreases by forcing the wild life to migrate in other areas. Modeling is needed in this area.
- See the paper H.I Freedman, J.B Shukla and Y Takeuchi, Population diffusion a two patch environment, Math. Bio Sciences, Vol 95, No 1, pp 111-123, 1989 .
- J.B Shukla and B. Dubey, Effects of changing habitat on food species: application to Keoldeo National Park, Ind. Ecol Model., Vol 86, pp 91-96, 1996

Protection of Rivers Lakes and Reservoirs-01/02

- Most of the big cities in India are located on the banks of rivers. Due to various kinds industrial and household sewage and discharges in the river, the water has become highly polluted cannot be used directly for any purpose other than agricultural use. The oxygen content of the water has also decreased to such an extent that even fishes are not able to survive.

Protection of Rivers Lakes and Reservoirs-02/02

- Algal Bloom is also a problem for lakes and reservoirs.
- The effect of joining rivers is also very important buts its impact on the environment and ecology must be studied.
- J.B Shukla, A.K Misra and Peeuysh Chandra, Modeling and analysis of the algal bloom in a lake caused by discharge of nutrients , Applied Mathematics and Computation, Vol 196, pp 782-790, 2008.
- J.B Shukla, A.K Misra and Peeuysh Chandra, Modeling and analysis of the depletion of dissolved oxygen in eutrophied water bodies affected by organic pollutants,
- Non linear Analysis: RWA, Vol 9, pp 1851-1865

Ecological Hydrodynamics

- This is another important area where modelling is needed. It is the combined study of Ecology and Hydrodynamics. This knowledge is needed to control landslides during monsoon rain, flooding , increased water seepage by using plantations, survival of fish populations in rivers maintenance of fresh water lakes, etc.,. It can also be used to study environmental and ecological impacts while joining rivers.
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Environmental Pollution, Health of Humans and Ecosystems-01/03

- Environmental pollution is caused by industrialisation, urbanization and population growth. Poverty also contributes to pollution because poor people often use firewood or coal for cooking. Moreover, the poor often are forced to live in habitats that are not conducive to good health.

Environmental Pollution, Health of Humans and Ecosystems-02/03

- Air pollution affects health of humans and ecosystems. For a proper understanding, modeling is needed. My group is working on it and has published many papers in journals such as Atmospheric Environment.etc,.
- See the following papers
- J.B Shukla and R.S Chauhan, Unsteady dispersion of an air pollutant from a time dependent point source forming a secondary pollutant. Atmospheric Environment. Vol 22, No,. 11, pp 2573-2578, 1988.
- J.B Shukla, Shyam Sundar and A.K Misra, Modeling the Removal of Gaseous pollutant and particulate matters from the earth amosphere of a city by rain: the effect of cloud density
- Environmental Modelling and Assessment, Vol 13, pp 255-263, 2008

Environmental Pollution, Health of Humans and Ecosystems-03/03

- The models related to the effects of environment and ecology on the spread of infectious diseases have been proposed, first time in the world.
- J.B Shukla, V. Singh and A.K Misra, Modeling the spread of an infectious disease with bacteria and carriers in th eenvironmnet.
- Non linear Analysis: RWA, Vol12, pp 2541-2551, 2011.

Global Warming-01/02

- It is well known that due to greenhouse gases like carbon dioxide, methane, etc., the average temperature is increasing slowly but surely affecting all species on the planet earth including agriculture, forests, seawater, etc., .It can spread infectious diseases such as TB, Malaria, Dengue, etc., in the Northern Hemisphere, where, at present, they do not exist. It can affect the polar ice caps, cause glacial melting, sea level rise, migration of population in coastal areas, etc.,. A modeling study is needed for all such type of problems. We are involved with working on such type of problems for modeling.
- Aerosols and bacteria an important roles in combating global warming. Aerosols capture CO2 and bacteria eat methane.

Global Warming-02/02

- See the following paper
- J.B Shukla, M.S Chauhan, Shyam Sundar and Ram Naresh, Removal of carbon-di-oxide form the atmosphere to reduce global warming : a modeling study
- Int. Journal of Global Warming, Vol 7, No 2, pp 270-292, 2015.

Aerosols and Artificial Rain-01/02

- Rainfall is an important bur complex phenomenon in nature. Aerosols are fine particles and can increase condensation of water vapors as cloud droplets and thus rain is formed.
- Aerosols of calcium chloride and calicium oxide are used for artificial rain making.

Aerosols and Artificial Rain-02/02

- See the following papers
- J.B Shukla, A.K Misra, R Naresh and P Chandra, How artificial rain can be produced? A Mathematical model ,
- Non Linear Analysis RWA, Vol 11, pp m2659-2668, 2010
- J. B Shukla, S..S Misra, A.K Misra, and R Naresh, Modeling the removal of gaseous pollutants and particulate matters from the atmospheree of a city by rain: Effects of cloud density.
- Environment. Model. Asses, Vol 13, pp255-263.2008
- A.K Misra, A .Tripathi, R Naresh and J.B Shukla, Modeling and analysis of the effects of aerosols in making artificial rain
- Model. Earth. Syst. Environ,V ol 2, pp- 179-190,2016

Effects of Toxicants/Acid Rain on Forest Resources and Agricultural crops-01/02

- Due to toxicants /pollutants forest resources
- Agricultural crops , reservoirs, etc are affected.
- See the following papers for details of modeling and analysis.

Effects of Toxicants/Acid Rain on Forest Resources and Agricultural crops-02/02

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- H.I Freedman and J.B Shukla, Models for the effect of toxicant in a single species and predator-prey systems. J.Math.Bio, Vol 30, No 1, pp 15-30,1991.
- J.B Shukla and B Dubey, Modeling the depletion of and conservation of forestry resources: Effects of population and pollution,
- J. Math. Bio, Vol 36, No 1, pp71-94,1997
- J.B Shukla, S. Sundar S. Shivangi and R. Naresh, Modeling and analysis of the acid rain formation due to precipitation and its effects on plant species,
- Nat. Res. Mod, Vol 26, pp 53-65, 2013

Eco-terrorism

- A Terrorist can start a forest fire as well as burn down agricultural crops in rural areas without any body knowing it. The fire can also be started in places where agricultural produce is stored for crushing, cleaning etc.
- How to control eco-terrorism is also a problem that needs to be modeled. In fact, the Naxalites are pursuing this method to terrorise farmers in the Naxalite infected areas of India.
- We are working in this area.

Sanitation, Nutrition Medication and Meditation-01/02

- It is well known the above mentioned factors play an important role in improving the health of human population.
- It is very important to study the following by using mathematical models.:

Sanitation, Nutrition Medication and Meditation-02/02

- i) How to study the effect of sanitation on the spread of infectious disease and how to control it.
- ii) How to study the effect of nutrition and human heath, especially on children.
- iii) Effect of medication in order to control various diseases.
- iv) Effect of meditation (enhanced oxygenation) on human health.
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Emotional Dynamics

- As humans, we interact with people in our homes; place of work and in society in general. Mostly, with some people, our relations are superficial but with a few it is very deep and strong. Why? A model is needed .This research may be termed or coined as emotional dynamics. Why is the divorce rate in rural sector of India very low as compared to the Urban and metropolitan sector?

Empowerment of Women: A Model -01/02

- In India, women have been respected since eternity. Many Gods are personified in the form of a Woman. Some of them, namely, are Parvati, Saraswati, Laxmi, Durga, etc. Over a period, the role of women tended to be relegated to domestic chores and activities. With a few exceptions, women in the rural sector have been deprived of education, adequate health, freedom of expression, of mutual interaction outside the household.

Empowerment of Women: A Model -02/02

- Therefore, a mathematical model is needed to empower them by considering all variables related to society, economics, equity and justice to empower women.

How to Solve the Terrorism Problem: A Model for Terrorism-01/04

- In India, we are aware that thousands of our people are living in forests in several districts of Bihar, Jharkhand, Chattisgarh, Madhya Pradesh, Andhra Pradesh etc., .They are influenced by and at times forced by so-called Maoist or Naxalites. These Naxalites are preventing the common people from entering mainstream of Indian society. They are wrongly teaching the people that the forests and land belong to them and the Indian government are controlling you and not giving you freedom.

How to Solve the Terrorism Problem: A Model for Terrorism-02/04

- I want to tell a fact of History. When I was a student nearly fifty years back, the king of Jharkhand revolted for independence against the Indian Government. Indira Gandhi was the prime minister at that time.

How to Solve the Terrorism Problem: A Model for Terrorism-03/04

- A war took place between the King along with his tribe, having elephants, bow and arrows against the Indian Army having modern warfare machinery. The army, with the government's permission, killed the King. Since that time these people of Jharkhand and elsewhere think that Indian are ruling over them from New Delhi.

How to Solve the Terrorism Problem: A Model for Terrorism-04/04

- To solve this problem we have to look at the real underlying issues involved and attempt to construct a model that may help to find a permanent solution. A similar approach is called for while dealing the Kashmir problem.
- See the following
- A. Goyal, J.B Shukla, A.K Misra and A. Shukla, Modeling the role of government effort in controlling extremism in a society,
- Math. Meth .Applied. Sciences, 2014.

Democracy: A Model-01/03

- A vibrant Democracy must have a ruling party and a strong opposition party where the opposition must able to express itself fearlessly, sincerely and should oppose the government with constructive criticism in national interest. A good model for a democracy is needed.

Democracy: A Model-02/03

- I wonder whether we can have a model that can predict and ensure the opposition lead by Congress (??) wins the 2019 general elections. It is interesting to note in modelling the following the two models would be different.

Democracy: A Model-03/03

- How to make a model so that the opposition UPA, lead by Congress, wins the election.
- How to make a model that ensures that NPA, led by BJP, loses the election.
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- The modelling process and various variables governing these two problems are very different but final outcome is the same. Can we model this problem?

Sustainable Development-01/04

- It is well known that the carrying capacity of earth is limited and therefore the need for a concept or some criteria arises for an objective assessment of industrial, economic, social development of our society. Sustainable development, a multifaceted concept, been has defined as the development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs.

Sustainable Development-02/04

- Although it has been widely endorsed and accepted at national and international fora , in both developing and developed nations ,the concept is still wide open to interpretation , criticism and revision in terms of measurement and quantification. All industrial and economic development must take into account all factors related to environment, ecology and wildlife, including the protection of biodiversity, flora and fauna in both terrestrial and aquatic systems of a region under consideration.

Sustainable Development-03/04

- All developing countries should design their own models of sustainable development as environmental, ecological, economic, social, political and cultural conditions are different in each region/country. In order to achieve the goal of sustainable development and improvement in the quality of life and social welfare, the need of times is to adopt both short term and long term measures for population growth, resource conservation, environmental protection and equitable distribution of the benefits of development.

Sustainable Development-04/04

- A vital step in this direction would be to understand not only what is being done in terms of utilization of resources and their conservation at the local / regional levels but also to be able to predict their impact on the development process for future generations.
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Urbanisation-01/03

- Urbanisation may be defined as gradual increase in the proportion of population in the urban areas

Urbanisation-02/03

- Urbanisation is caused mainly by the following factors:
- Growth of resources (infrastructure) in urban sector, such as housing, health, education, transport, security, etc.
- Natural increase in the urban areas caused by expansion of infrastructure due to population growth and rural migration.

Urbanisation-03/03

- Growth of income of some individuals (big farmers and land lords) in the rural areas encouraging them to migrate to urban areas in order to have better quality of life and resources for themselves and their families (pull migration).
- The unemployed population in the rural areas who go to urban areas in search of jobs and eventually some of them settle there. They work as service providers and supply cheap labour to the urban people (push migration).
- A good model is needed for urbanization and rural migration by taking unemployment into account.

DNA Sequences(Genome)-01/02

- It is hoped that India will lead the world in many aspects including social, cultural, intellectual, etc., in a few decades. It is noted here that many people in Northern territories of Australia, Canada , West Indies, South America etc., have similar colour, body structure , etc., but their ways of living are different due to different geographical environment and historical reasons. I wonder if could find a genome sequence to prove that all these are the same, at least genetically.

DNA Sequences(Genome)-02/02

- I have a friend in South America who is having Indian features. We first met in Mathematical Ecology Workshop in Trieste, Italy. At lunch often, we used sit together on most of the days. I always had milk, while he had coffee or beer. If, somehow, I missed him he would call me Dr. Shukla come here with your milk. He is now an internationally known expert in genetics. He once told me that we are of the same origin. It has been proved by DNA sequencing.

- Are our actions governed by DNA sequence? Is it related to what we are doing? Do we have no control on our actions?

- Has the sinner a different DNA sequence than a saint ?

- Can we mathematically model some of these problems?

Human Body-01/02

- How to model the various functions of the human body? Is there a relation between thoughts and wisdom? Why are doing things we are doing? Why are we born humans and not animals or trees etc? Is there a thing called destiny related to DNA sequence ?

Human Body-02/02

- Does thought travel faster than light? While light rays require a medium to travel in the form of waves, the mind does not need a medium (I think)
- We need more models to study such problems. Can technology change destiny?
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Bio-fluids-01/03

- The human body is filled with bio-fluids. Its function depends upon bio-fluids. The functions of the mind , heart, lungs, etc, are examples .

Bio-fluids-02/03

- The function of various body parts of human, animals and plants also depend on bio-fluids. . For example how is water up taken by plants against gravity to the top crown?
- Mucus transport in the lung due to cough.
- Flow of bio-fluids in the body under diseased conditions,
- Effects of body forces caused by magnetic field, electric field, gravity, mental forces etc, on body functions.

Bio-fluids-03/03

- I have worked in the area of bio lubrication that includes human `joint lubrication. The effect of magnetic field on the lubrication process has also been studied.

- See the paper J .B Shukla and S.P Gupta, Effects of peripheral layer viscosity on peristaltic transport of a bio-fluid , J. Fluid Mech, Vol 97, Pt 2 225-237, 1980.

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Fluid Lubrication-01/02

- Fluids play important roles in reducing friction between two mating surfaces, smooth or rough, in absence or presence of external forces. Some example are mechanical bearings, human joints, rolling contacts, etc,.
- See the following papers
- J.B Shukla, Principles of Hydromagnetic lubrications,
- J. Phy. Soc. Japan, Vol 18, No 7, pp 1086-1088, 1963.

Fluid Lubrication-02/02

- J.B Shukla, Optimum one dimensional magnetohydro-dynamic slider beaeing.
- Trans. ASME, J. of Lub. Tech, Vol 92, , Series F, No 3, pp 530-545, 1970.
- J.B Shukla, A new theory of lubrication for rough surfaces.
- WEAR, Vol 49, No 1, pp 33-42, 1978.
- P sinha, J.B Shukla, C Singh, K.R Prasad, Non Newtonian lubrication theory for rough surfaces: Application to rigid and elastic rollers.
- J Mech. Eng. Sciences, Vol 24, No 3, pp 147-154, 1982.

Technology-01/02

- Technology is affecting Society. How to model technology and its effects? Is it making the rich richer and the poor poorer? Are poor people's standard of living improving? Are we becoming any wiser due to increase in technology? Are we less humane due to technological development?
- Models to study the effects of technology on human behaviour is needed.

Technology-02/02

- J.B Shukla ,A Goyal, K Agrawal and A. Shukla, Role of technology in combating social crimes : a modeling study,
- Eur. J. Appl. Math, Vol 24, No 4, pp 501-514, 2013

Awareness Programs by Media-01/02

- The effect of awareness programes by media on the following systems have been studied
- 1. On the spread of infectious diseases.
- 2. On the conservation of forest resources.
- 3. Effect of sanitation on human health
- 4. Effect of nutrition on human health

Awareness Programs by Media-02/02

- A.K Misra, A. Sharma and J.B Shukla, Modeling and analysis of the effect of awareness programs by media on the spread of infectious diseases,
- Math. Comp.Mod, Vol53, pp 1221-1228, 2011
- A.K Misra, A. Sharma and J.B Shukla, Stabiulity analysis and optimal control of an epidemic model with awareness programs by media,
- Biosystem, Vol 138, pp 53-62, 2015

Conclusions

- To conclude, models in the following areas are needed:
- How to increase the carrying capacity of the earth.
- Global warming : Effects and Control.
- Sanitation, nutrition and meditation: Effects.
- Technology and Terrorism

- Hard work and original research recognized.

- FICCI Award(1980). A top technology Award in India.
- SSB Prize(1982). A top Science prize in India.
- Life time achievement awards from two Indian academies(Mathematics)
- Life time achievement awards from two Indian Science Societies.
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