INTRODUCTION
All species (living or nonliving including humans) on this planet earth, their functions, their interactions among themselves, with their environment 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.

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. Real modeling research can be conducted if your mind is on fire for new discovery.

According to the famous mathematician Ramanujam “An equation for me has no meaning until it represents the thought of God” That thought, I feel is Nature and Society.

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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.

In the following let me mention some phenomena in nature and society which require mathematical modeling

**Carrying Capacity of the Earth**

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.

i) **Land for Agriculture and Other Resources for Food Production.**

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 seasons, the time when rivers become very narrow leaving aside fertile soil where vegetables of all kinds can be grown.

Waste land can be used for plantation, horticulture, agriculture etc.,

Roof of houses can be used for farming of vegetables
ii) **Housing:**

Additional housing may be planned in deserts areas underground as well as inside hills.

iii) **Education and Health**

There should be free internet faculty for education and health. We should have internet Universities and heath care centers.

iv) **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 using ecological methods.

See the following paper,


**Darwin’s Theory Of Evolution**

**Wild Life Protection And Biodiversity**

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.

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 resources are available for their survival in the habitat.
We have models which can prove this concept in an open environment. For details see the following paper


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.


**Protection of Rivers, Lakes and Reservoirs**

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.

Algal Bloom is also a problem for lakes and reservoirs.

The effect of joining rivers is also very important to control flood and to provide irrigation in drought affected areas. Its impact on the environment and ecology must be studied. Some relevant papers are

J.B Shukla, A.K Misra and Peeuys 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

**Environmental Pollution, Health of Humans and Ecosystems**

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.

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. I have received SSB prize in 1982 for work in this and related areas.

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.

**Global Warming and Climate Change**

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 play important roles in combating global warming. Aerosols capture CO2 and bacteria eat methane.

See the following papers
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


**Aerosols and Artificial Rain**

Rainfall is an important but complex phenomenon in nature. Aerosols are fine particles and can increase condensation of water vapours as cloud droplets and thus rain is formed. Aerosols of calcium chloride and calicium oxide are used for artificial rain making. See the following papers for details.

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

A.K Misra, A .Tripathi, R Naresh and J.B Shukla, Modeling and analysis of the effects of aerosols in making artificial rain
**Effects of Toxicants/Acid Rain on Forest Resources and Agricultural crops**

Due to toxicants /pollutants forest resources Agricultural crops, reservoirs, etc , are affected due to acid rain.

See the following papers for details of modelling and analysis

H.I Freedman and J.B Shukla, Models for the effect of toxicant in a single species and predator-prey systems.  

J.B Shukla and B Dubey, Modelling the depletion of and conservation of forestry resources: Effects of population and pollution,  

J.B Shukla, S. Sundar S. Shivangi and R. Naresh, Modelling and analysis of the acid rain formation due to precipitation and its effects on plant species,  

**Sanitation, Nutrition Medication and Meditation**

It is well known these factors play an important role in improving the health of human population.

It is very important to study the following by using mathematical models.: 

(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.
Awareness Programs by Media

The effect of awareness programs 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

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 sectors?

Modeling study is required to formulate the emotional interactions of two or more people in a society. The roles of family and friends are very important to affect this interaction in a positive mode.

This modeling approach (concept) can also be applied between two or more nations during conflicts.

Empowerment of Women: A Model

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.

In developed countries, due to education and use of technology women empowerment has grown.

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

A Cobb-Douglas type of function defining empowerment has been proposed by me which includes some of the above mentioned variables.
Eco-terrorism: Forest Resources and Agriculture

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.

How to Solve the Terrorism Problem: A Model for Terrorism

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.

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.

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.

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
Democracy

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.

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.

1. How to make a model so that the opposition UPA, lead by Congress, wins the election.
2. How to make a model that ensures that NPA, led by BJP, loses the election.

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

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. 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. 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. 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.

**Urbanisation**

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

Urbanisation is caused mainly by the following factors:

(i) Growth of resources (infrastructure) in urban sector, such as housing, health, education, transport, security, etc.
(ii) Natural increase in the urban areas caused by expansion of infrastructure due to population growth and rural migration.
(iii) 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).
(iv) 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.

**Bio-fluids**

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

1. 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?
2. Mucus transport in the lung due to cough.
3. Flow of bio-fluids in the body under diseased conditions,
4. Effects of body forces caused by magnetic field, electric field, gravity, on body functions.

See the following papers


J.B Shukla and S.P Gupta, Effects of peripheral layer viscosity on peristaltic transport of a bio-fluid

M Agarwal, M King, B Rubin and J.B Shukla, Mucus Transport in a miniaturized simulated cough machine: Effects of constriction and serous layer stimulant.

J.B Shukla, Hydro-magnetic theory for squeeze films.

**Hydro-dynamic Lubrication**

Fluids play important roles in reducing friction between two mating surfaces, smooth or rough, in absence or presence of external forces. I have worked in the area of biofluid lubrication that includes human `joint lubrication.

The effect of magnetic field on the lubrication process has also been studied.

Some example are mechanical bearings, human joints, rolling contacts, etc.,
J.B Shukla, Principles of Hydromagnetic Lubrications,

J.B Shukla, Optimum one dimensional magnetohydro-dynamic slider Bearing.

P Sinha, J.B Shukla, C Singh, K.R Prasad, Non Newtonian lubrication theory for rough surfaces: Applications


**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.

A combined model using equations for hydrodynamics and ecological growth (logistic model) has been proposed by me. This research work is being discussed with Prof. T.J Pedley of Cambridge University U.K who visited IIT Kanpur, a few months ago.

**DNA Sequences (Genome)**

Can we have a model to show that human characteristics are determined by DNA sequences?

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?

Using DNA sequence, is it possible to find people living in different continents having the same origins?

For example, it may be noted 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.

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

**Human Thoughts, Mind, Behavior and Spirituality**

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)

The human mind is very dynamic. It controls all of our physical senses( sight, hearing, smell ,touch, and taste) And then our thoughts, actions and feelings? ). Is it is possible to control our mind? It is said that that only with the intellect(wisdom) can one control the mind. Is there a relation between thoughts and mind? Why are doing things that we are doing?

How can we free ourselves from this worldly bondage of sufferings? Are our actions related to DNA sequencing?

Is the Universe governed by an unseen force ? Are we controlled by a force called Almighty(God)? How to prove that existence of the Almighty? Are we a part of God’s infinitely wide envelope? Can we approach the Almighty by doing good Karma? Is doing everything possible for others, without hoping anything in return, is good Karma? Why are we born humans and not animals or trees etc?Is it because of good Karma? Is there a thing called destiny? Is it related to DNA sequence? Can destiny be modified by good Karma? Can environmental characteristics including technology change the destiny of an individual ?

A balance is needed between technology and spirituality for peaceful living.

We need models to study such problems.
**Technology**
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.

See the following papers

**Conclusions**

To conclude, models in the following are needed for the survival of all living species.

- 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 is 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.