

Box UN
(NRS)
(India) JW

UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT

STOCKHOLM, JUNE, 1972

FUTURE HUMAN SETTLEMENTS AND ENVIRONMENTS OVER OCEANS

(Topic 1 of item 4 of the Agenda of the meeting of the panel of Experts on Human Settlements, United Nations Headquarters, New York, 20 - 21 January, 1971, i.e. Planning for Settlement Development).

By

Shiw Mangal Singh

Secretary,
International Natural Hazard and Future
Environment Research Society

Village: Jaitpur Khas

P.O. Sonawan

District: Faizabad

U.P. (INDIA)

I N T R O D U C T I O N :

Man has always looked forward at future with curiosity and anxiety and ever since the dawn of civilization he is continuously striving for a better future. Phenomenal advance in science and technology in this century has opened new vistas for future human welfare. Man has already penetrated the barriers of outer space and has already landed on Moon. Technologically he is on the verge of carving future homes in outer space, air and over high seas.

Note: References in numerical order have been given towards the end of the Text.

In the course of time the spatial perspective of future welfare has gradually widened. Primitive man worked for the future of his family, the Neolithic for his clan and the mediaeval man for a kingdom or similar political unit that unified him with his fellows. Global character of problems in the 20th century has given future an International character and since 1950 several attempts have been made by U.N. and other agencies to pool ideas from more than one nation for the future welfare of more than one nation. One of the important steps of this kind was the International Arid Lands Meeting in Socorro in 1955 to ponder over the future of arid lands. This was followed by Portland (August 1966) and Washington (October 1967) meetings to look into the Next Fifty Years; 1967-2017. The Tucson (June 1969) International Conference on Arid Lands in A Changing World, had a lot of future orientation. In 1970 a landmark was reached when Geographers, Earthquake Engineers, Townplanners, Architects, Biologists, Geophysicists and Poets established the International Natural Hazard and Future Environment Research Society and launched the programme of study "Settlement Ocean Surface". Helsinki-Jyvaskyla (June - July 1971) International Conference on environmental Future discussed events to come and tasks to be done.

Aquatic Human Settlements or Aquasets ?! Why ?

Population forecasts indicate that by 2900 A.D. there will be "one hundred people for every square yard of the earth's surface ¹ ~~including seas~~ [†] and man will overwhelm his habitat. These ideas though overpessimistic, are definite alarm signals. Man is going to out number land resources in a few centuries and

.... rational land-man.....

rational land-man balance is bound to break. Already it is partly broken in industrial areas mining areas, over populated agricultural regions and large metropolitan areas and has damaged either man or environment or both. Ill health, poor living and narrow thinking are some of the symptoms of damage to man, death of natural beauties, degraded and polluted environments and stinking wastes are the signs of a damaged environment. If man wants to utilize his grand heritage; the resource, in Gordon Childe² fashion as an "active partner" and attain a high material, social, aesthetic and metaphysical standard, he must find other alternatives for living places than on the land. Alternatives already known to us are water, air, and outer space. Water is the most suitable frontier of future settlements. This is the only virgin frontier left where man will be able to produce biological food. Living over earthly water surfaces will be cheaper and more comfortable than in the air or in the outer space. Oceanic settlements will have more desalinized water to use when fresh water supplies on land become inadequate in the next century.³ More over oceanic settlements will have closer time distances from already inhabited land masses, where man has continued to live since his birth than the air and outer space settlements. Man is more aquatic by nature than airborne or outer space borne. Most probably he was more aquatic in the past,⁴ and seashore was one of his primitive homes.⁵ Man had permanent dwellings on the inland water surfaces. Neolithic lake dwellings found in various parts of the world attest it. Even today a good number of people live over water surface permanently or over 75% of their lives. Sample studies conducted by the author in various parts of the world suggest that, if given the three alternative dwelling place choices, 90% will opt for aquatic settlements.

/Where is the

Where is the first Aquaset (Aquatic Settlements) Frontier ?

Oceanic frontages of Eastern Asia, Western Europe, Eastern North America and West Central South America abound with marine life about 20% of which is fit for direct human consumption. These regions have a highly developed fishing industry. All the above regions including Indian Ocean are rich in marine life and marine life feed, and produce over 80% of sea food. All the above regions, excluding the west central South America have a high density of human population in general. Population problem in East Asia and the Indian sub-continent is acute and a large proportion of people are unemployed or under employed and conditions will probably not experience a revolutionary change during the centuries to come. These lands have vast scope for industrial development and this sector will probably absorb several hundred times more people than what it employs today. There is limited scope for agricultural development. On the present cultivated and cultivable lands, without inflicting irrecoverable damage to environment. The scope to increase production even after the success of green revolution is not more than 1 to 3. It is not likely to be more than 1 to 5 even after the successes on the present intensive settlement frontiers i.e. deserts, tropical forests, flood plains and undulating surfaces. Food, water and power projects like those in Puerto Penasco in Mexico will have limited capacity to develop coastal deserts. Even if all the deserts bloom (this will not be an environmental degradation but a welcome change) the scope for an increase of agricultural production in East Asia and the Indian sub-continent is not phenomenal because only China and India have deserts of any considerable size. Thus after a century or two India, China, Japan, and Indonesia will probably have to stream migrants to aquatic settlements over shallow portions of Arabian sea.

Bay of Bengal and western pacific and first aquatic settlers will probably be Japanese, Chinese, Indians and Indonesians. According to recent surveys these regions have some of the highest potentials in marine life productivity. Incidentally some of the first Neolithic settlements to store fish were established in these regions over five thousand years back.

In western Europe, eastern north America and west central South America, the point of break might come at a latter date, when population might diffuse over the surrounding seas. Other parts of the world will reach this stages at a much later date.

Aquatic resources on which Aquasets will depend

Oceans have four major types of resources; (1) Biological, (2) mineral, (3) Natural beauties and (4) Atmospheric, Biological marine resources of the food chain can be placed under five major heads; (i) vegetation, (ii) invertebrates, (iii) fish, (4) reptiles, (v) mammals. Out of these fishes, invertebrates and vegetation are the most important sea foods. Though there are over thirty five thousand types of fishes, fishing industry depends on only a few. Important among them are cod, flounder, herring, mackerel, salmon and tuna. Out of the invertibrates crab, clam, lobster, oster, prawn, shrimp and squid are important sea foods. Some of the reptiles can also be used as humanfood. Out of the marine vegetation marine algae is important. It is commonally used as sea food in China and Japan. Thus the largest success of oceanic settlements will be on the food front. Oil will be produced from the mammals. Besides the above pearl and sponge will be produced on large scale.

/Another important

Another important marine resource is the beauty of oceanic landscapes. It can serve as a base of flourishing tourist industry. In the submarine aquariums of the aquatic settlements it will be possible to exhibit marine life in protected natural habitat. Air craft carriers and submarines will be used for peaceful purpose of transporting tourists to the oceanic beauty spots. Sea bottom forests, hills, valleys and glittering fishes will form parts of a true heavenly landscape. Hotels will start "hire your own boat and submarine" system to stimulate youthful tourists from settlements on the land to visit aquatic settlements, and thus provide real Polynesian romantic atmosphere.

Oceans are rich in various types of minerals. Offshore petroleum drilling has already started ~~it~~ in several parts of the world and the age of prototype aquatic settlements has already began. Sodiumchloride, magnesium, potassium chloride and phosphorus are also treasured there. Rich manganese outcroppings have recently been found over the oceanfloor. This finding has stirred international action on the problem of jurisdiction of sea bed and U.N. has already set up a committee to study it. Oceanic minerals will support a thriving manufacturing industry.

Strong oceanic wind will be an important atmospheric resource. It will help enormous power generation. Steam power plants will also generate electricity and produce salt and fresh water. Oil and nuclear power plants are also a possibility in the aquatic settlements, though in the former case pollution hazards of special type will be high and in the latter case the structures might be too heavy for the floating aquatic settlements.

/ Fertilizer industry

Fertilizer industry will thrive on the wastes of seafood processing plants, human wastes and materials like potassium chloride. Fish feed and poultry feed will be manufactured from the wastes of seafood industry, some of the human wastes and non-edible marine life such as certain types of sea snakes and sharks. This will be utilized for handfeeding fishes on the seafood farms, and chicken on the poultry farms of the aquatic settlements. Flourmills to manufacture egg flour and fishflour will be run profitably. Protein will be manufactured from oceanic petroleum and materials like Antarctic Krill and man's future food will be richer, than the present food.

Successful experiments in Israel⁹ and India¹⁰ suggest that sea water can be directly used for irrigation. Thus it will be possible for the aquatic settlers to grow fruits and vegetables in their miniature orchards and fields over the aquatic settlements. Land masses will export soil for this purpose. Even soil less fields in glass houses will be a possibility.

It is well known that fresh water supplies in the world are becoming inadequate year by year due to population growth. In 1966 the ratio of available fresh water to needed fresh water was 50 to 1 and by the year 2000 A.D. it will go down to approximately 20 to 1.¹¹ By 22nd Century there will be a dangerous deficit of fresh water in the world and sea will remain the only dependable source of it and in all probability aquatic settlements will become great suppliers of fresh water to the land masses. A regular water tanker service or pipeline service is a possibility between some of the settlements on the lithosphere and hydrosphere. Another alternative to it might be an artificial increase in the evaporation

/ of marine

of marine water near aquatic settlements and a higher amount of precipitation over the landmasses. However this increase in evaporation might affect marine life.

Homes for 21.9 billion people can be carved over the Oceans

Oceans have a surface area of about 146 million square statute miles and an estimated optimum productivity of about 200¹² to 250 million tons of fish under natural ecosystem. If we include the potential productivity of edible marine flora also this figure can be raised to over a thousand million tons. On the basis of this it can be concluded that the potential carrying capacity of oceans under the natural ecosystem will be about 8 persons to a square mile. However this figure can be raised to over 150 persons to a square mile, if non-edible resources of oceans are included in the carrying capacity and sea food and poultry is produced under man-made ecosystems in the marine life farms and poultry farms. On the basis of this estimate it has been calculated that the oceans can support 21.9 billion people or about three times more people than what the world is going to support in 2000 A.D.

It will be cheaper to carve marine life farms, poultry farms and aquatic settlement over oceans than to reclaim shallow continental shelf for agriculture and irrigate worlds deserts with scarce fresh water to produce low value agricultural crops and carve desert-colonies.

Carrying capacities of oceans (both shallow and deep) lying within the first aquatic settlement frontier (Western Pacific and northern Indian ocean) is not uniform. The distribution of marine fauna and its feed: Phytoplankton and zooplankton and other life forms is also highly uneven in various parts. Migratory nature of

@ It is well known that most photosynthesis takes place in oceans and there is more fauna in the oceans than on the land.

marine fauna also results in erratic carrying capacity. Temperate shallow seas lying within this area have a higher carrying capacity. These areas are rich in edible marine life and marine life feed and China and Japan are important fish meal producers. However resources have began to dwindle in this region recently due to over production. Tropical portions of the region (tropical pacific ocean beyond Indonesia and Indian ocean) have vast potentialities for marine life exploitation.

Hazards in the Aquatic Settlements (Aquasets)

Structures, resources and man in the aquatic settlements will be extremely exposed to natural and human hazards. Among the natural hazards most dangerous will be storms, floating ice, high surf, glare, volcanic eruptions, lightning, earthquakes and above all migration of marine life vital to people. Among the human hazards important ones will be; atmospheric and water pollution, overuse of marine resources, traffic and transportation hazards, communication hazards such as heat and radioactivity caused by lasers and sinking of the settlements due to overload above the plimsoll marks. Many of the above mentioned hazards are interlinked and the origin of one might culminate in several chain reactions.

As soon as man will domesticate marine life and establish permanent habitations over high seas, a phenomenal change will occur in both marine and land ecosystems of the earth. This is why care, study, and observation is prerequisite to permanent habitations. Reactions of human timid marine life, to continuous humans presence, to human and mechanical noises, to the process of domestication of marine life into farms, need a continuous and deep study. Would edible species overwhelm nonedible ones or the vice versa ? The question of probable changes that the land ecosystems

/might experience

might experience after a large scale transformation of marine environment also deserves a continuous mental and laboratory exercise. Will there be higher frequency, duration and magnitude (FDM) of natural hazards on the land, are life giving rains on the landmasses going to be affected by it, how human communities will react to oceanic wilderness, will be some of the questions to be answered.

As soon as sea becomes the home of man, marine environment will be exposed to the dangers of pollution. In spite of the automatic purification power of sea through oxidation of organic matter, pollution problem will continue to be serious. It will affect both shallow and deep sea flora and fauna. Marine fauna will be continuous victim of pollution by hydrocarbons that deposit an isolating film on the water surface. Some of the pollutants favour useful marine life while others such as DDT are inimical to it. They upset ecological balance, kill the enemies of the useless ones in larva stage and trigger multiplication of useless ones. One of such phenomenon occurred in South Pacific recently when crown of thorns starfish that feed on coral, multiplied in a short time and posed a grave threat to the fishing industry of Malaysia, Australia, Tinian, Saipan, Midway, Hawaii, Fiji and Solomon islands.

But the above hazards are within the reach of the controlling hand of man. Armed with science and technology, rational perspective planning, a suitable environmental design and management technique, man will be able to stop, control or regulate them.

Environmental Aims and Aspirations of 22nd Century

Why such a long perspective?

Future objective without time limit is illusory like Mirage and time limit is the second dimension of a goal. Short time limit plans of five, seven or ten years duration adopted by planned

societies are like the twinkle of an eye in comparasion to the long human past and even longer human future. No doubt they are the stepping stones of our march towards our goal; the total develop- ment with super environment [@] and super human beings, and thus they are valuable. But very often they create the lust of economic bonanza in man and deprive posterity of its due share. This is particularly true in the case of non-renewable resources and environmental pollution or phenomena like glass house effects to cause heat deaths. This is why a perspective of over one and a quarter centuries i.e. 22nd century has been taken, though long range perspective is at times coupled with the difficulty of projections and their accuracy and to some extent it mars the mission of long range perspective planning.

A projections of man's scientific and technological achievements reveals that 22nd century human society will be a quasi-cybernetic society; a society with phenomenal efficiency in work and living, with natural ecosystem largely eliminated and mans individual freedom dangerously eroded. Man will become the sole measuring scale of the environment and a catastrophe will be approaching. EDM (frequency, duration, magnitude) of various kinds of hazards will be on the increase. Man the parasite will become the dictator of the ecosystem and the co-existence between the two will cease exist. This will be against our goal. We do not want 22nd century parents to tell the bedtime story to their children, "Once upon a time there

@ Efficiency in work and living, scenic spots, stimulating uninterrupted total development, protecting individual and society, their freedom and their creations from hazards and a quest for the unlimited and unknown are some of the qualities of a super environment.

* Human beings above social, religious, economic and racial bondages, living over international waters under the banner of United Nations. Persons belonging to such a community will have a higher individual freedom than 20th or 21st century Urbanites, whose individual freedom is continuously being eroded away by the society.

was a landscape called forest, where an extinct animal called lion used to live and extinct bird called nightingale used to sing and extinct plant called cherry used to blossom. Biological organisms that became extinct due to natural selection can be seen in fossils, but those who became extinct due to human selection cannot be seen even in that.

Marine Environmental System (MES) Analysis and Design: A Pre-Requisite to Aquatic Settlements (Aquasets)

The principal of survey of environment, analysis of various variables, its regionalization into environmental systems, determination of carrying capacities of different environmental systems under different technologies is a pre-requisite for the uninterrupted success of oceanic settlements. Otherwise they are bound to suffer the fate of 19th century Everard and Musgrave Ranges Pastoral company and Arltunga ghost-town of Central Australia, that died because of the ignorance of the people about the land they wanted to settle. ¹⁴ The question of human adaptability also needs deep thinking and research. Because new settlers with wide bridge of adoption usually fail.

Environmental systems have a repetitive pattern of environmental values and their design varies according to ~~four~~ 4 Ps. - perception, purpose, priority and period in spatial context. Environmental values can be calculated with the help of various attractive and repulsive factors of physical and human environments and time dimensions. The method of calculation of environmental values on the basis of the formula -

$$\text{Log } \frac{E}{V} = f \left[(\log \frac{N}{e} - \log \frac{N}{h}) + (\log \frac{H}{e} - \log \frac{H}{h}) + \frac{(PPP) \times T}{123} \right]$$

and design of environmental systems based of empirical studies in flood-plains has been discussed by the author elsewhere. ¹⁵ The same with slight modifications can be applied to the marine conditions.

Contrary to the case of flood plains, data for the design of micro-marine environmental systems are not available for all oceans of the world. But the same for meso and macro scales are available in reports of various oceanographic research institutes and oceanographic expeditions, works of the PM section of the IBP and imageries of remote sensors. Imageries of remote sensors provide useful and speedy data for designing macro-marine environmental systems. A lot of valuable data of this type has been collected by the NASA.¹⁶

Marine environmental values can be calculated according to the formula:

$$\text{Log } M_v = f \left[(\log M_e - \log M_h) + (\log H_e - \log H_h) + T(\log T-P) + \frac{PPP}{123} \right]$$

Where M_v is marine environmental value, M_e is marine natural environment, M_h marine natural hazard, H_e is the marine human environment and H_h is human hazard, T is time dimension: projection of aims and aspirations, science and technology etc.), P is Probability of truth of these projections, PPP is perception of priorities.
 ppp
 123

After calculation of environmental values according to the above formula from empirical data, the oceans can be divided into marine environmental systems and mapped. Regions with highest environmental values should form the first settlement frontier and should be settled first.

If regions with lower environmental values are to be settled first due to certain causes, an inter-environmental system insurances scheme should be followed. An Insurance scheme for floodplains has already been discussed elsewhere¹⁷ and it can be applied for the settlement of low value marine environmental systems also.

Insurance of continuous economic prosperity, life and property in the low value environmental systems can be done according to the following formula:

$$\text{Log } I_p = f (\log E_v + \log I_{eg} - \log T_{ap})$$

Where I_p is insurance profit, E_v is environmental value, I_{eg} gains due to inter environmental cooperatives and T_{ap} time adaptability premiums.

Whole process of settling the oceans can be divided into three stages.

- (1) The stage of Research and analysis of environmental values and Design and mapping of marine environmental systems.
- (2) The stage of plan preparation to intermarry environmental systems with aims and aspirations and adaptability: physical, economic, social, educational, health, legal, political, scientific, technological and so on.
- (3) The stage of Plan effectuation:- finding settlers and capital and manufacture of prefabricated structures and equipment for resource use, living and protection from hazards.

Aquaset Environmental Design

Outer Shape and load bearing frame:-

Marine environmental design has to be a true translation of our aims and aspirations mentioned above. In the following pages four parent designs have been critically examined in the above reference. They reflect both symbolic and usonian values.

All of the four parent designs selected have a symbolic significance and are familiar to common man throughout the world. □ symbolizes the end of the proof or the attainment of final truth in statistics. It resembles the geometric shape of religious alters, and also the

/plan of mans

plan of mans ancient most habitations and cultivated fields or
parnis. ¹⁸ It is a popular settlement plan in China, Japan, India ¹⁹ ²⁰
and elsewhere. + the next parent settlement design is a sign
of addition in mathametics and it is indicative of continuous
growth. It symbolizes the red cross; an international society,
that organizes service to the victims of disasters. It is also a
symble ^o_^ of one of the world's great religions: Christianity.
N the next design is the symbl ^o_^ of finite population size in
statistics. It indicates the last frontier of human settlements
on the surface of the earth; the oceanic frontier and thus it
is warning signal to the growing numbers of men and their activities.
It suggests men to think and get ready for alternative living places
in air and outer space. ✠ the next design symbolizes the true,
the good, the beautiful and the prosperous. It is a religious,
cultural and economic symble ^o_^ of Hinduism and Buddhism. It
represents the cosmic cross whose cardinal points are the corners
of the universe. ✠ had been a base of widly used settlement
designs in ancient India ²¹ and the East.

Least water coverage and most living and working space should
be the guiding principle of the outer shape of oceanic settlements.

The following table reveals the results of factor analysis of
various parent environmental designs selected:-

/Design

Design	Indices of Attractive factors per unit area			Total	Indices of Repulsive factors per unit area		Total	Indices of Net attractive Factors per unit area
	Fish Farm	Working and living space	Shelter to means of trans-port		Timidness to marine life and surface coverage hindring evaporation			
□	0.40	1.00	0.00	1.40	1.00	1.00	0.40	
+	0.24	0.36	0.09	0.69	0.36	0.36	0.33	
N	0.20	0.60	0.10	0.90	0.60	0.60	0.30	
℞	0.30	0.68	0.32	1.30	0.68	0.68	0.62	

On the basis of the above table the above designs can be arranged in the following order

of attractiveness. 1. ℞ 2. □ 3. + 4. N . However the analysis of the construction cost (same material, same height, same area) results in a completely changed order: 1. □ 2. N 3. + and 4. ℞. □ is the cheapest and ℞ is the costliest but the cost of construction should not be the guiding factor for the establishment of primary activity dependent oceanic settlements. There is every chance that the cheapest □ will become a ghost town in a few years because of the migration of untamed or wild marine life. However it will have a continuous life, if marine life is domesticated in marine life farms.

The Internal Shape of Future Oceanic Settlements

Least internal space coverage by structures and maximum living and working space providing equal social, economic and religious opportunities to settlers should be the guiding factor of the internal design of the oceanic settlements. A circular design with homo-internal shape is one of such designs. It will, help the settlement to float and carry a larger load of equipments, products, structures and population and make the inhabitants feel equal.

After a critical examination of designs of various primary activity dependent settlements found in various parts of the world, the circular pit type from Rhodesia, modified Nuba Ring (with pit inside) from Sudan modified spindle type (with pit inside) from Europe, east of river Elbe and modified Bororo type (with pit inside) from South central Brazil have been selected. Each one of the above will form one neighbourhood. The houses will be arranged in Circular or spindular form around the pit. Every family will have equal houses, equal land and equal distance from social and religious places in every neighbourhood. The fronts of the houses will face the pit and the backyard will face the marine life farm in the open sea. The pit will be a public place having a park and a swimming pool, a social and religious place and a shop. The backyard will be used for drying sea food and scientific and scenic observations of the sea. The pit design is familiar to people in various parts of the world and it is well within the range of human adaptability. It will have least exposed surface to suffer from environmental hazards.

Four storey prefabricated house units (two stories above and two below the plimsoll mark) are recommended for primary

/activity

activity settlements. It is possible to build 40 units with public facilities per acre. Light concrete, reinforced with steel (lying in the 9th stage of Building material stability)²² can be used for walls and floors. With an average of 5 persons per family, one acre of residential area will be able to accommodate 200 people, 100 permanent residents and 100 tourists. Every family can be allotted a 500 acres fish farm, 0.01 acre poultry farm and 0.1 acre shelter for private amphibious means of transport.

In the secondary and tertiary activity dependent settlements, processing and packing plants and container service yards can be constructed towards those ends of the load bearing frames that lie on the leeward side of usual wind and ocean current direction. This will help in controlling and regulating pollutants. Public Offices and shopping centre can be constructed in the centre facing the pit.

In the case of such isolated and small communities as proposed in this paper, it will not be possible to construct a school and a dispensary in every settlement. "School on the Air" and "Flying Doctors Service" can be adopted as an alternative to this. This system is already in common use in the isolated and small communities in Central Australia.²³

An airport with environmental research station can be constructed towards the end of the settlement on any of the load bearing arms. The airport will boost the services of airborne ambulance units and tourist industry.

The Colour of Structures

Great care has to be taken in the choice of colours of structures. Contrasting colours will make the settlement beautiful amidst an environment with monotonous colour (marine blue). However it might be highly repulsive to certain types of marine life. Thus matching colour or marine blue will be the most suitable colour of /structures.

structures. Also it will symbolize the colour of the unlimited and unknown.

The Humanized Oceanic Landscape: a Projected Profile

After the development of settlements over ocean surfaces, the oceanic landscape will look like a bamboo forest over a flat topped hillock. Radio and television towers, radars and cranes will form the upper sky line and the buildings will look like a hillock.

@@@@@@@@@@@@@
@@@@@@@@@@@
@@@@@@@@@
@@@@@@@
@@@
@

- 16 (a) Ewing, G.C., ed., Oceanography from Space, Woods Hole Oceanographic Institute, 1965.
- (b) NASA, Space Applications, Interim Report, (Summer Study 1967,) Vol. I, II, III, Washington, 1968.
- (c) Pierson, Jr.W.J., Some application of Radar Return data to the Study of Terrestrial and Oceanic Phenomena, Proceedings of the Third Goddard Memorial Symposium on Scientific Experiments for Manned Orbital Flight, Washington, 1968.
- 17 Singh, Shiw Mangal, Utilization of Floods Plans of Middle Ganga Valley, Opp. cit.
- 18 Singh, Shiw Mangal, Turrufs Babhnauti and Raoter in the Ganga-Ghaghra Doab West; A Study in Land Settlement, Social Georgraphy and Rural Central Places, The National Georgraphical Journal of India, Vol. XI, 1965.
- 19 Hall, R.B., Some Rural Settlement Forms in Japan, Geographical Review, Vol. XXI, No. 1, 1931.
- 20 Tant, Bruno, Houses and People of Japan, Tokyo, 1958.
- 21 a. Acharya P.K. - Indian Architecture (Shilpashastra) Vol. I, II, III, IV, V., 1927.
- b. Havel, E.B. - Ancient and Medieval Architecture of India, 1915.
- 22 Singh, Shiw Mangal, Storage and Building Material Stability, Chapter IV of the unpublished book Human Settlements and Environments.
- 23 The author studied this system when he visited, Alice Springs Region, Central Australia in 1964.
- 24 Donald, N Michael, The Unprepared Society: Planning for a Precarious Future, New York, 1968.
- 25 Royal Commission on Environmental Pollution, ~~(1971)~~ (1971 -) Annual Reports, H.M.S.O.

@@@@@@@@@@@
@@@@@@@
@@@
@