the formation of planar landslides. This has to be countered by suitable design and construction measures, which, however, may impact only the cost-benefit ratio of the project and not its feasibility.

The last leg E-E4 of the canal is located amidst essentially bands of claystone and clay-shale and their weathered derivatives, with only subordinate layers of sand rock, as adjudged from the description of the vibro-core cuttings of 15 holes put down in this reach of the canal. This reach of the canal requires intensive studies of slope stability, using the geological information as is available now, for plotting a number of geological cross sections, using which slope-stability analysis, based on the soil mechanical properties of the slope forming materials, has to be carried out.. In this connection it is necessary to point out that the proposed excavation of the canal with slope of 3H to 1V, shown in the project feasibility report of 2004 put up in the website of the project to be unsuitable, as the formations constituting the northern slope dip into the excavation at an angle of less than 5° from the horizontal.. The low depth of excavation of 1-3 m in the last reach of the canal is a favourable feature; however, this has to be balanced against the unfavourable features promoting slope instability. In this connection, it is necessary to recognize the very low gradient of the ocean floor north of the canal, which is as low as 500H to 1V [approximate] which seems to indicate the expectable degree of slope stability under the existing saturated conditions below the sea level. The increase in the cost of excavation, in order to obtain the required factor of safety against sliding by the provision of berms and flatter slopes of excavation require due consideration.

Shri Rajendran has rightly drawn attention to the need for defining the extent of blasting to be done for the construction of the canal. Unfortunately, there is no reliable data available from the exploration done, for estimating the quantum of blasting to be done. This is because all the 44 holes of shallow depth, put down for the exploration are by vibro-coring method, which does not help one to visualize, from the cuttings, the integrity and hardness of the material *insitu*, undisturbed by the strong impact of vibratory drilling.

Lastly, I would like to suggest the formation of a board of consultants for tendering "advice and consent" on all aspects of project design and construction, as has been done for the successful execution of several major river valley projects in the country. This stipulation of periodic expert review, during design and construction, using the design and construction memoranda furnished by the project engineers is preferable to the imposition of an experts committee, on the project to examine all aspects and pronounce on the feasibility of the project at this stage of project development, seems to me to/be unrealistic , because it may not be conducive to the unfettered progress of a project of national importance, to be executed with expedition and with the required safeguards for ensuring its safety and successful performance.

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THE GIS APPROACH TO GEOLOGY, HYDROLOGY AND ENDEMICITY CORRELATION

The science of Medical Geology – the outcome of a continuous and concerted effort of the past few decades' relentless data collection, collation and crystallization of ideas — is fast emerging as a new offshoot of geoscience. The fact that the endemic characteristics of most of the non-biogenic diseases have a direct bearing with the local geogenic factors has long been known to many ancient civilizations since time immemorial. The ancient Romans were well aware of the negative effects on human health of the mining activity and the Chinese epics dealt in detail with the relationship between rock crushing and the accompanying pulmonary diseases. Besides, elemental deficiencies leading to various ailments were also known to many old civilizations. The all-important difference, as of now, is the application of the state-of-the-art.

The element-specific abiotic diseases acquiring an endemic nature in a confined geological domain forms the focal point of Medical Geology, involving inter alia the earth scientists, the environmentalists and the medical profession.

Although in its nascent stage, research related to the Medical Geology holds both promise and potential for its far-reaching immediate social applicability. Collation, correlation and compilation of data, related to the geological mapping and detailed environmental studies of an affected area, constitute the pre-requisites for ascertaining the

causative geogenic factors. Further, the accompanying interwoven anthropogenic factors also need to be carefully taken into consideration.

It is an established fact that the geology of an area, with a specific rock-chemistry, is responsible for imparting a definite composition of the groundwater and its vicinity. Field data confirm that over and under presence of any specific element(s) in the local groundwater gives rise to a particular disease(s) affecting the human beings and/or animals of that area. An in-depth GIS-based study can categorically pinpoint the 'culprit' contaminants and thus help detect, diagnose and mitigate or arrest the prevailing endemic disease. Fore such studies, GIS application is contemplated to be of immense use considering the vast and varied types of data-handling required for such study. Ironically, the fact remains that medicine has very little and limited role to offer where geogenically-driven endemicity is prevalent; an area where geoscientists' role is of paramount importance. Radhakrishna (*JGSI*, v.66, p.399, 2005) recently pointed out that "any concerted effort at finding out the trace metal content in the mineral, soil and water samples and ascertaining the differences existing between region to region has not been attempted". He emphasised the need for such studies in the rural parts of India.

The present model suggests a three-tier (layer) based study of GIS application, for probing the causative factors. The layers to be prepared for the study are (a) the geo-inputs, (b) the water analysis data and (c) the disease details.

The database concerning geo-inputs should have as much geological and geo-environmental information as possible viz. detailed mapping, structure, radon emission data, photogeolgical data, geochemical and geophysical information etc.

The second layer should constitute a detailed analysis of local and adjoining groundwater composition of both the shallow as well as deeper aquifers. The third data layer includes information related to the prevailing disease viz. density, intensity and other relevant characteristics of the disease. Once this fundamental database is ready, judicious interplay and superimposition in a permutation combination of these mutual information layers is to be undertaken. While toying with the fed data, a whole new range of data set is expected to be generated which on interpretation should throw new light in identifying the causative factors of the prevailing endemicity. The ultimate attempt is to identify the existing element-disease link. It is the GIS applicability that can provide a true insight into this aspect and into the mitigation of the disease.

Characteristics of any prevailing endemic disease in a granitic country are supposed to be different from the disease of an area dominated by basic/ultrabasic rocks. For example, the former, with a greater abundance of Si and Al, is potentially supposed to have a greater likelihood of alumina and/or fluorine-related disease than in a terrain with a predominance of basic/ultrabasic lithology. Researchers at the National Institute of Mental Health and Neuro-Sciences, Bangalore and elsewhere are postulating a link between high alumina concentration in brain tissue and the Alzheimer's disease. Similarly, limestone and a pure sandstone country are expected to exhibit distinctly identifiable endemicity patterns owing to the contrasting lithology. Here, the former would presumably indicate a calcium-related disease whereas the latter would exhibit a disease that may or may not be related to calcium. Similarly, it is possible to encounter a high rate of osteoporosis, osteomalacis or any other calcium-deficiency disease in a country located over an orthoquartzite country where calcium concentration in local groundwater is reasonably low.

A medically recognised fact is the role Na and K in Coronary Artery Disease (CAD). Similarly, in the domain of agriculture, hyper/hypo-sodic and hyper/hypo-alkaline soil types determine the crop pattern of an area, its attendant role in the Medical Geology, can be better understood with the help of suggested three-tier study of GIS application.

Recognition, diagnosis and mitigation of endemic pattern with the help of identified parameters related to lithology-pathology correlation, with the help of GIS study is suggested. Consequently, along with doctors, geoscientists can play a more meaningful and effective role in the mitigation of endemic diseases.

Predictably, the more varied kind of data is fed into the GIS, the better insight it is expected to give, thereby heralding a new beginning in the realm of Medical Geology.

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