Response to the article "India Based Neutrino Observatory: Potential Geological, Radiological And Biological Impacts" dated 26 September, 2012 placed on 'Countercurrents.org' by Shri V.T. Padmanabhan, MA, and (available at http://www.countercurrents.org/vtp260912.htm)

(For the sake of clarity all extracts from the aforementioned article by Shri V.T. Padmanabhan are given within quotes and shown in italics, followed by the response from the INO team in bold font)

"A unique science laboratory is coming up deep inside the mountains in Idukki-Theni districts of Kerala and Tamilnadu in India for neutrino research. The lab has to be located in deep underground with 'walls' and roof of at least 1000 meter thickness for filtering the cosmic rays. There will be a big laboratory of 3432 sq meters in area and 32.5 meters in height and three smaller ones of 1600 sq m and 10 m high. The length of the tunnels will be 2491 meters and its portal of entry is in Theni district of TN. The projected life of the lab is 120 years. This mega science project of the Department of Atomic Energy (DAE) costing Rs 1,300 crores was approved for XIth five year plan. Tunneling will start soon. High energy neutrinos manufactured in Neutrino Factory at Chicago in USA will be beamed towards INO to study the changes occurring during the journey."

The primary goal of the INO lab is to study naturally occurring neutrinos in Earth's atmosphere. There are many theoretical studies about the possibility of studying neutrino beams but this is not a reality today, nor likely to be in the near future (next 10-20 years). So no neutrino beam will be sent from Fermilab to INO.

"Neutrinos are part of a group of fundamental particles known as leptons. There are 12 fundamental particles -6 leptons and 6 quarks. All matter in the universe are thought to be made of these particles. Neutrinos are produced in Sun and other stars. They travel in straight line at near speed of light. They come in different energy levels starting with a few electron volts (eV) to trillions and even higher eV. Sun is the major source of neutrinos on earth. Every second more than 6 million solar neutrinos pass through every square centimeter area of our body. Most of these are of low energy of Million eV (MeV). Solar neutrinos and other low energy

neutrinos are the least hazardous as they interact with other matter particles extremly rarely. Occasionally particles of ultra-high energy are also seen and they interact with matter more often and vigorously and create radioactive particles."

All neutrinos irrespective of their energies are safe. Typically a neutrino has to zip through 10,000,000,000,000,000,000 people before even interacting. In this rare interaction, the neutrino will just produce either an electron or a muon depending upon the neutrino type which will go through the human body. Thousands of such muons and electrons produced by cosmic rays are going through our body everyday.

"The neutrinos I am discussing here are the ones made in Neutrino Factories (NF) and Muon Colliders (MC), which are currently in the design stage and are expected to be operational 2020 and 2022 respectively. These neutrinos are different from the natural neutrinos in following respects:

1.Energy level : The muon neutrinos manurfactureed by CERN and other accelerators have maximum energy of 5 billion eV (GeV). NF neutrinos will be in the range of 500 GeV and MC muons are expected to achieve an energy level of 1500 GeV."

Neutrinos are same whether produced by cosmic rays in our atmosphere or in a neutrino factory. The neutrinos that could be produced in a neutrino factory (whenever such a factory becomes a reality) will have energies in the range of 15-20 GeV and not 500 GeV. Please note that the energy of the cosmic ray produced atmospheric neutrinos can vary from less than a GeV to 100 GeV or even more. So in our atmosphere there is higher energy neutrinos than that could be produced in a futuristic neutrino factory. In addition, all neutrinos irrespective of their energies interact rarely with matter.

Note that 1 GeV corresponds to about 4 times 10^{-14} KCal, i.e., it is about a millionth of a billionth of a KCal; 1 gm of rice corresponds to about 4 KCal.

Another simple example is when we strike a match approximately the amount of energy released in these units is approximately about 10 billion million GeV.

2. "Intensity Level : all the natural neutrinos are travelling as independent particles, where as the factory made neutrinos will be collimated to higher intesity.

3. Mono-energetic - Neutrinos of varying energy levels will be segregated."

It is not possible to segregate neutrinos of different energies. Even in the neutrino beam, they will not be mono-energetic, there will be a spread of energy.

"High-energy, high intensity, mono-energetic beam of muon neutrinos dispatched from the Fermi National Laboratory towards INO are quite different from the individualized, particle shower the planet experiences constantly."

Even in a neutrino factory (that may become a reality in future), the neutrinos will not be mono-energetic. This is not to state that mono-energetic neutrinos are bad but just to put the facts in place. However no neutrino beam will be dispatched from Fermilab to INO.

"The newly proposed site for the INO (77 deg17 min 5.32s E 9 deg 56 min 46.20s N) is located near Pudukkottai in Pottipuram village. The project site is abutted on the western side by the high ranges of the southern Western Ghats. The major townships around the site are Bodinayakkanur on the north about 18 km away, Theni on the north-eastern side about 35km away, Chinnamannur situated (~25km away) on the south-eastern side and Kambam (~21km away) on the southern side. Pottipuram village is connected to the nearby townships by road. A cart road leads up to the INO portal site. Nearest railhead is at Bodinayakkanur.

The portal of the tunnel leading to the caverns will be located nearby Pottipuram Veerappasamy temple while the caverns will be built about 1 km underneath the high hillock of Ambarasakaradu." ii "The caverns and the tunnel will be located underneath the Bodi-west Reserve Forest area. The 1.75 km long horizontal tunnel cutting through the charnockite rock, slopping down slightly with a gradient of 1:13.5 beneath up to the Kerala state border leads to the laboratory. The caverns are located with in Tamil Nadu state."iii

As per The Sketch in REIA (figure 2) there are 5 tunnels, with a total length of 2,491 meters. There are also 4 caverns, instead of 3 in the text and table 2 of EIA. The cavern No 4 (10mx10mx10m) is located at 1000 meters on the main tunnel. The direction of the tunnel is South-East to North-West from the portal till 1960 m. At 1960 m it bends to the right and the direction for the next 100 meter is South to North. At 2060 m it bends again to the right and the direction is South-West to

North East. The last portion, named as auxiliary tunnel is 224 meter long. Cavern No 3 is located at 1900 m, parallel and west to the tunnel. Cavern 4 is also similarly located at 1000 m from the portal.

If the Kerala state border is located at 1750 meters from the portal, then 740 meters of tunnel including 211 meters of the main tunnel and all the remaining four tunnels and caverns 1, 2 and 3 are all located within Kerala. Total volume of the carved out space of INO is 236,000 cub meters. Of this, 77,310 m3 is located underneath Tamil Nadu. That means, the remainder 159007 m3 or 67% of INO is within Kerala state."

The arithmetic is wrong. All tunnels are not in a straight line, as the figure shows. This is just a sketch. The entire cavern and lab complex will be in Tamil Nadu.

"A collimated high energy neutrino beam hitting an atom bomb hidden in a silo or submarine can cause its explosion. High energy neutrino beams can also be used as a tactical weapon to kill a small group of leaders/commanders with high radiation within minutes. This is useful for 'regime changes' or 'war against terrorism'. Since neutrinos cannot be blocked by any material, this is a defense-less weapon. No time for early warning either."

These are all speculative ideas. No such collimated high energy beam of neutrinos exists. So the possibility of its being used as a tactical weapon does not arise.

The author mentions in his list of "assignments" that he is working on neutrino weapons, but that is not the focus or interest of the scientists working on INO, which is a pure-science research lab.

"INO site selection was not transparent. There are several issues concerning the safety of the people and the Eco-system which need to be discussed and resolved. The key issues of concerns are listed below:

VIOLATION OF Frderal Pincipes: According to DAE, the tunnel will end at the Kerala border and the laboratories (caverns) will be in Tamil Nadu. From the sketch and descriptions given in the project documents, 700 meters of the tunnel and the

main cavern and the two smaller ones will be under Kerala. Sanction has been obtained from the Government of Tamil Nadu; Government of Kerala has not even been informed."

INO is a national project funded by DAE and DST. It is an underground science lab, for basic sciences research. The project is entirely located within Tamil Nadu. No part of the underground laboratory falls within Kerala.

As per established government procedure, since the project will be entirely within Tamil Nadu, all procedures to engage the various departments of the Government of Tamil Nadu has been followed. In fact a State Level Committee, chaired by the Chief Secretary of Tamil Nadu is continuously monitoring the project. This Committee so far met five times.

All statutory clearances for the project have been obtained from the Government of India after discussions at various levels starting from the state government agencies. It has been presented to the Experts Committee of the MoEF, Government of India. Only after detailed discussions the Environmental and Forest clearance was obtained from MoEF.

While it may to true that the State of Kerala has not been officially informed, however the project has been enthusiastically publicized by local media in the neighboring district of Idukki in Kerala.

"Since even a hairline crack in the wall (one km wide) or the roof can topple the detector, digging of wells or development projects like irrigation tunnels, mining etc. will have to be banned within a kilometer from the laboratory cave."

This is a misleading argument . Let us offer an analogy. Most homes have walls about 10 feet high and typically have water pipes a few inches thick coming through the walls. We do not expect the walls to topple because of making a hole for the pipe!! Similarly, the size of the INO lab under the mountain is in roughly the same proportion to the pipe in the wall. In addition, geologists have surveyed the site to ensure the rock is of good quality and is stable. No surface activity can disturb or upset the safety of the lab. So there is no question of banning of any activity like digging wells or irrigation tunnels, mining in the nearby areas within a kilometre.

"RADIOACTIVE CONTAMINATION: Official studies conducted in US and Europe Papers written by health physicists working with accelerators in Fermilab, CERN etc

show the potential of high dose radiation-contamination, hundreds of kilometers away from the factory and detectors. Most of the neutrinos beamed from Chicago will pass through the detector laboratory and emerge through the land above the laboratory. Radioactive particles like carbon14 and tritium will be generated by the hadron shower at the point of emergence and these can travel long distances along with stream and groundwater."

Even if a neutrino factory comes up in the future at Fermilab, it is more than 10,000 km from INO, in fact, from India! Even if there is contamination 100s of kilometers from the factory, we are more than 10000 km away on the other side of the globe! Even then this statement is without references and the content questionable. Also, note that the article talks about "factory and detectors" but only neutrinos reach the detector and not any of the other "radiation" over a distance of more than 10000 kms.

"IMPACT ON DAMS -Idukki is a geologically sensitive district with a dozen reservoirs (within 60 km of INO) holding some four billion cubic meters of water which is the lifeline for three districts in TN and Kerala. Dams can be impacted in two ways: (1) Explosion induced seismicity. The cave making involves removal of 800,000 tons of hard rock with about 5 to 10 lakh kg of explosives, 3 times a day for three-four years. (2) Radioactive contamination of water. If radiation-contamination occurs, the dams will have to be emptied. Farm products can also be contaminated which can cause the collapse of the plantation economy and tourism."

The author has in several places referred to the "Frequently Asked Questions" on INO. This FAQ has a seismic map of India which shows that the project site is in Zone 2, which is seismologically the lowest possible zone in India (there is no Zone 1). So the statement about Idukki (being the district in Kerala adjoining the project site) being in a "geologically sensitive district" is also false and misleading. Since there is no radioactivity associated with this project, the statement about radioactive contamination of water and farm products is not only wrong and misleading but guaranteed to generate a fear-psychosis in the minds of the people who are being misled by this article.

It should be noted that Idukki dam is about 40 - 50 kms as the crow flies to the project site in Theni district. Mullaperiyar dam is also about 100 kms from the project site.

To appreciate the impact of tunneling on dams, or more correctly non-impact, consider Pykara dam in the Nilgiris which is about 10-15 kms from the PUSHEP underground hydro-electric project which was commissioned

recently in 2004. Nearly 13 kms of tunnels were constructed under the northern edge of Nilgiri mountains for the PUSHEP project below Glenmorgan Forebay bringing waters from Pykara dam. No danger to Pykara dam was envisaged and has been reported. Furthermore, the Singara heritage power house built in 1932 is about 200m from the main access tunnel portal to the underground project. No damage was caused to this heritage dam during the construction of the tunnels and the underground powerhouse which took more than ten years to complete.

"ACCIDENTS LIKE BEAM MISDIRECTION. Under accidental conditions like loss of electricity, beam misdirection is possible. In such cases, if the beam emerges through high-occupancy places like schools can irradiate a lots of people will be harmed."

False and misleading. First of all, the detector that will be the focus of INO will study naturally occurring atmospheric neutrinos and there are no beams. Even if in future beams are made available from CERN or Fermilab (which is not a possibility today), neutrino beams in any foreseeable future will not cause any radiation damage. The author seems to be mistaking neutrinos for neutrons or other radioactive nuclei and generating fear and confusion.

Let us also answer the hypothetical question on the possible danger of sending any neutrino beam to INO or for that matter in any part of the world. Let us assume that a neutrino beam is continuously being sent from, say CERN to INO lab (fiction at the moment). A person standing in front of the beam continuously throughout his/her life time (about 100 years) will find that only one neutrino has interacted with his/her body in a life time while all the rest-billions of them- have passed harmlessly every second. On the contrary millions of cosmic rays are passing through our body every day.

"INO's is a part of the US Fermilab project. Its mandate is to provide information on the quality of neutrinos detected at INO to the US lab, more or less like a hospital undertaking drug trials. The project proposal was written by scientists of Fermilab and submitted to the Indian Planning Commission for funding in Feb 2006. US is not likely to share the weapon developed with India. Details of this collaboration with US are not available in any of the document or official websites in India."

Fermilab has nothing to do with the INO project. The INO project was entirely conceived and conceptualized by Indian scientists. An MoU signed by seven

Indian institutes as early as August 2002 started this project. In 2005 a project report detailing the project was submitted by INO collaboration to DAE and DST requesting R & D funds. The project was also discussed by the Scientific Advisory Council to the Prime Minister chaired by eminent Indian scientist Prof. C. N. R. Rao on 27th August, 2005 and approved. Over the next 6-7 years the collaboration was involved in various R & D efforts and was also looking for a suitable site with the help from Geological Survey of India. Till today INO is an entirely Indian effort. Foreign participation in INO collaboration will be considered if necessary at an appropriate time, in the spirit of international collaborations such as CERN.

A group of scientists from several Indian Universities led by Delhi University however are participating in the neutrino program of Fermilab. In this program both the accelerator that is producing the neutrino beam and the detector that is detecting these neutrinos are both located in the United States. This program has no link with the INO program which is an indigenous program developed by Indian scientists.

"The idea of using neutrino as a weapon was first floated in 2003 by the scientists from Japan. The existing and the planned research can lead to the weapon. The neutrino weapon issue has not been discussed by the global disarmament community consisting of agencies of the governments/United Nations and also the peace movements. The societal, ethical and other aspects of these studies should be discussed widely."

Irrelevant to INO. INO is a project that will study the properties of neutrinos and is not a weapons facility. This is also stated in the FAQ and anyone stating the contrary is deliberately misleading the public.

"Cave making will generate about one million tons of muck, of which one lakh tons will be in dust form and 10,000 tons in nanometer size. This can contaminate the farmlands and water sources in TN portion."

The details about muck extraction, storage and handling are given in the FAQ, in more detail in the EIA. The total amount of rock debris, which is a useful construction material, is about 230000 cubic metres or about 600,000 tons. The muck will be carefully stored and then disposed off; in fact, it is good quality granite and will be useful in building construction. In fact, INO itself will make use of about 10% of the extracted rock. In addition, the author

seems to have a disrespect not only of facts but numbers as well, as he has inflated the numbers.

"We have only highlighted the known hazards of neutrinos published by scientists working with the neutrino research establishments. The knowledge about neutrinos is extremely limited. Even though billions of them are flying around, none of them are similar to the factory-produced ones. One does not know if their passage through different layers of earth can cause other major impacts like earthquakes. Because something like this has never happened before. There is also a concern that the Department of Atomic Energy may use the underground space for storing their high level radioactive waste from 20+ nuclear power plants. An underground space with more or less unlimited scope for expansion and nobody to monitor is tempting."

Again the author harps on about factory neutrinos. This is wrong. In addition, his science is wrong: the properties of neutrinos (fundamental objects) are the same whether they are produced in the factory or come from space from far-away galaxies in the cosmos. The author has let his imagination run away with him; perhaps he has been influenced by the movie "2012" which took many liberties with facts about neutrinos!! However, the reality is that this movie was not based on facts; however, one can expect only so much from a Hollywood movie!

Neutrino detector need to be located away from any radiation. In fact, we are putting this detector underground to avoid cosmic ray radiation present on the surface of the earth. So there is no question of storing radioactive waste there. The laboratory will be open 24 hours to students and researchers.

"Neutrino research has immense physics potential and societal value as well. The research will have implications for astrophysics, phenomenology and particle physics. Neutrinos hold the key to several fundamental questions on the origin of the Universe and the energy production in stars. Neutrinos can be used for tomography of the earth and human body also and they are less hazardous than X-rays. Neutrinos may tell us more about dark energy and dark matter and ultimately help us exploit them as the earth is getting depleted of its material and energy sources."

Parts of this para are quoted from the INO documents. The author should have mentioned the source. It is also clear that the above para is not in sync with the inflated fears and obsessions that riddle the rest of the document.

"However, its site related safety risks and global issues related to weaponisation should be discussed openly and the project need to be placed for public scrutiny."

Response: Relevant documents pertaining to the INO project are in the public domain, as is clear from the fact that the author of this article himself has quoted from them! Issues related to Site-related safety risks have been extensively discussed both in the FAQ and the EIA and are available for public scrutiny. The issue of weaponisation has nothing to do with this basic science project.