

Ethical Challenges in Science and Technology*

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I am particularly honored to receive the Quadricentennial Honorary Professorship of this well-known University, and I would like to congratulate the University of Santo Tomas for celebrating its 400th anniversary.

In the last 400 years, the world has changed, and changed greatly, without many people paying attention to it. We are now facing the problem of survival on Earth and today, I will talk about the ethical challenges in science and technology from a different perspective. In 1995, the Nobel Peace Laureate Sir Joseph Rotblat in his acceptance speech said: *"The time has come to formulate guidelines for the ethical conduct of scientists, perhaps in the form of a voluntary Hippocratic Oath"*. He argues that scientists should not pursue scientific truth simply for truth sake without considering the ethical implication of their research. He emphasizes the social responsibility of scientists and believes that holding an amoral attitude toward science is actually immoral as personal responsibility is tied to the likely consequences of one's actions.

Although the idea of an ethics for Science can be traced over that to Francis Bacon in the 17th century, pledges on the values and responsibilities shared

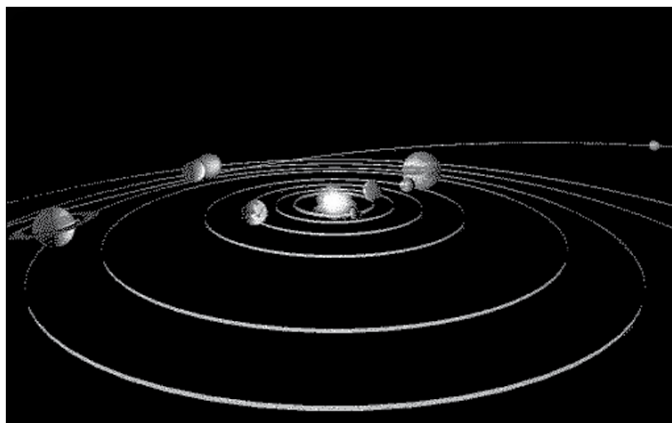
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among scientists and engineers have become quite common in recent years. For example, the Peace Pledge Movement for scientists launched in Japan in 1999 is committed to peace and the PLEDGE reads: *“I, undersigned below, pledge with honor and dignity to the best of my knowledge, I will not participate in the research and development, manufacture, acquisition and utilization of nuclear weapons and other weapons of mass destruction.”* It is certainly very important for the individual scientist to see to it that science reaps benefits to mankind and that it should not be used for evil purpose or cause unexpected negative consequences. Further, if we continue to engage in the fierce and highly vicious economic competition among nations resulting to inattention to global sensitivity, it might not be enough for the scientists not to participate in R & D, manufacture, acquisition and utilization of nuclear, biological, and chemical weapons or their means of delivery.

In the current stage of human development on earth, there is a difference between the responsibility of an individual scientist and that of scientists as a whole. If we do not fully appreciate and understand the consequences of competition and unlimited development based on individual consumerism in a globalized market driven economy, practicing so-called good science for good purpose can still produce miserable consequences among some of us and eventually all of us.

As we entered the 21st century, the shadow of the nuclear holocaust did not seem to disappear. However, the menace caused by global climatic change and biodiversity loss has started to seriously threaten the very existence of human society on earth.

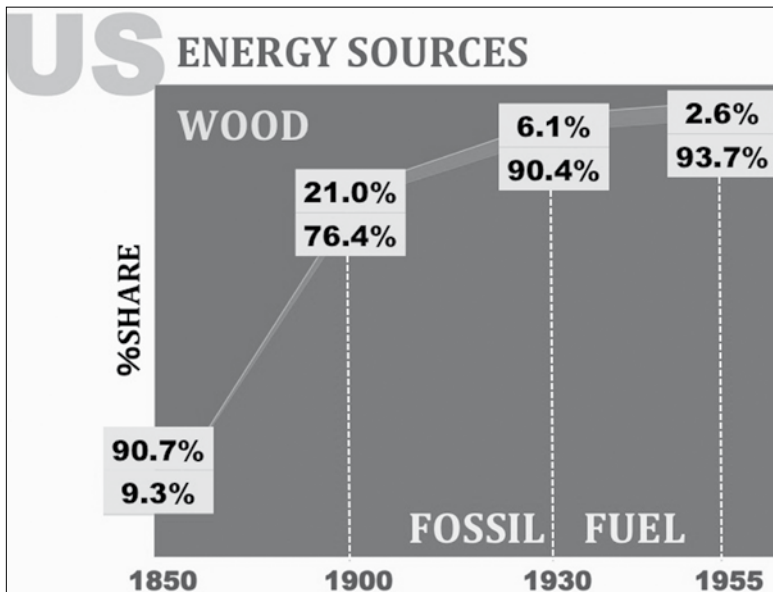


After the big bang, it took about 9.5 billion years before the formation of the solar system. Because of the special position of Earth's place in the solar system, it took only a couple of hundred million years before life started on the surface of the

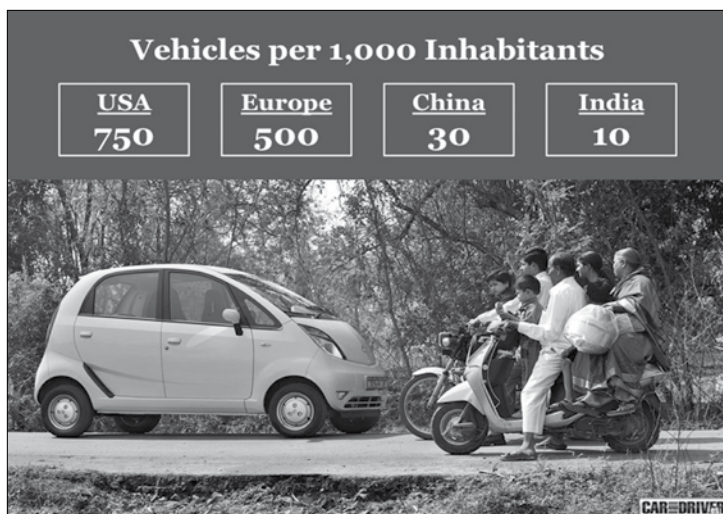
Earth when material cycling by sunshine started to happen. That made a big

difference with the rest of the planets that evolved along with the burning of the sun, and it will take another 5 B years before the sun burns out. But because of the recycling of the materials on the surface of the Earth, life is thriving abundantly. About 2 M years ago, our ancestors appeared on the surface of the Earth and evolution took place from ape to man. From that time on, because the numbers were relatively very small human impact on the Earth was not that great.

Looking at this painting which is a scenery of wedding ceremony of an aboriginal tribe in Taiwan more than 250 years ago, everything you see in it e.g. the houses, the clothes that people wear, etc. came from sunshine. But with the advances in science and with the industrial revolution human society took a big turn. There is hardly anything brought up from the sun anymore – all was dug out from the Earth with the use of fossil fuels. So, 250 years ago, there was a turning point brought about by the advances of science and technology and it took human society to graduate from sunshine and from nature and that transformation took place very quickly.



In 1850, 90.7% of energy in the USA came from the burning of wood but 80 years later 90.4% of energy came from the burning of fossil fuels. The change took place



very rapidly. In 1908, Henry Ford started to manufacture the automobile in an assembly line and went on to mass produce it. Now when you look at the automobile consumption in the USA for every 1000 persons, there are 750 vehicles;

in Europe 500 for every 1000 people. China now is the biggest market for the automobile industry. Two weeks ago, I was in Kyoto and it was said that by 2030, the way China is developing, the resources of the Earth will not be enough just to keep up to its carbon needs. Many Asian countries were using the people's car and the motorcycle before, but now, they are moving up in terms of automobile consumption.

Material comfort has also improved with the advances in science with chemists synthesizing new materials. All these things

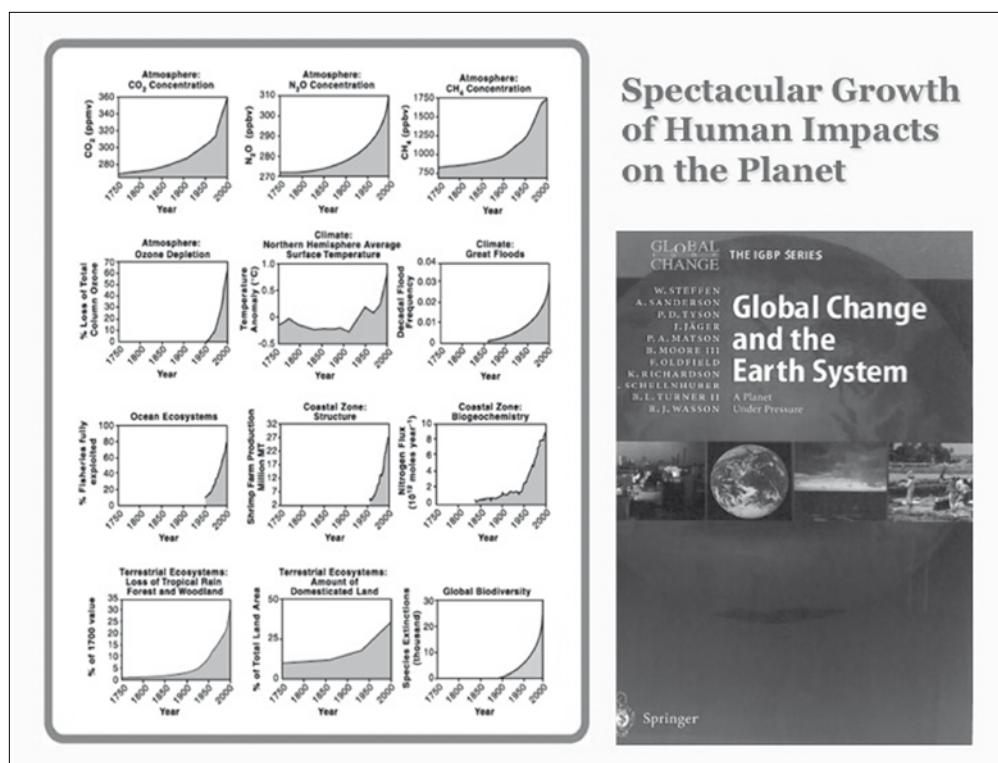


you see in the store, relatively available and relatively cheap products driving human societies to individual consumerism. After the Second World War, high technology gadgets were also mass produced. Japan, Taiwan, Korea, and China helped in the production of hi-tech computers, iPhone, iPad, etc. Technology has improved life considerably and made it more comfortable. Now, people in affluent societies live longer, healthier, more abundantly, but at the same time, they cause great changes and impact on Earth.

In 2010, the National Geographic's State of the Earth report says 6.8 B people now live on Earth and all together consumes 1.4 earth resources (food, forests, fisheries, minerals, etc.) If we all consumed like the Americans, it will take 5.4 earths to sustain us. When too many people consume too many resources, one consequence is the mounting pile of wastes. All these wastes are products that were chemically synthesized and people will look at these as the scientists' fault. But what I am worried about most is that we have arrived at a stage where we do not have much time left before we can do something good.

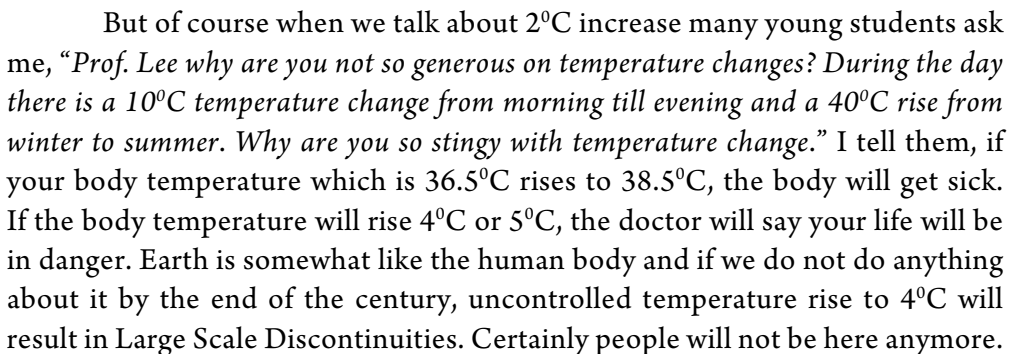


On the issue of global warming trend, the situation was quite stable if we look back in the past 10,000 years. Periods of Earth's warming and cooling

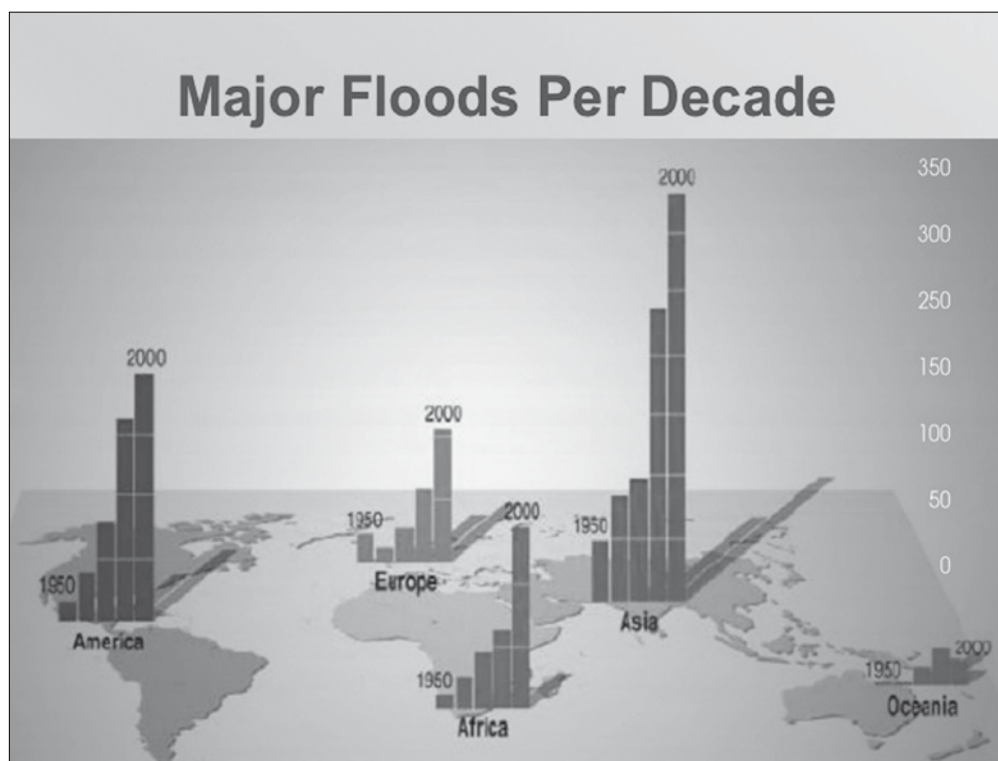


occur in cycles. The ice period occurs naturally every 25,000 years due to earth's combined axis of rotation and elliptical orbit. We are currently in the warm period. But when we look at the indicators of human impacts on the earth system, warming is not the only concern. We see increasing levels of Carbon Dioxide concentration in the atmosphere and great floods have also increased and bio-diversity loss is also increasing in the past 50 years. But of all the impacts on the planet, the thing I worry most is the global warming trend. Why, because we do not have much time.

This figure is the very famous burning embers chart updated in 2007 by the Intergovernmental Panel on Climate Change when Al Gore received the Nobel Prize, because he warned us of the dangers of global warming at that time. If you compare with the pre-industrial revolution the temperature is raised by 0.6°C, and if you look at the current situation, the Risk of Extreme Weather Events is already moving towards the orange color, it means we will see some extreme weather conditions occurring now. But the important thing is the Risk of Large Scale Discontinuities is currently very low. Of course the Risk to Unique and Threatened Systems, like low lying places and glaciers is already

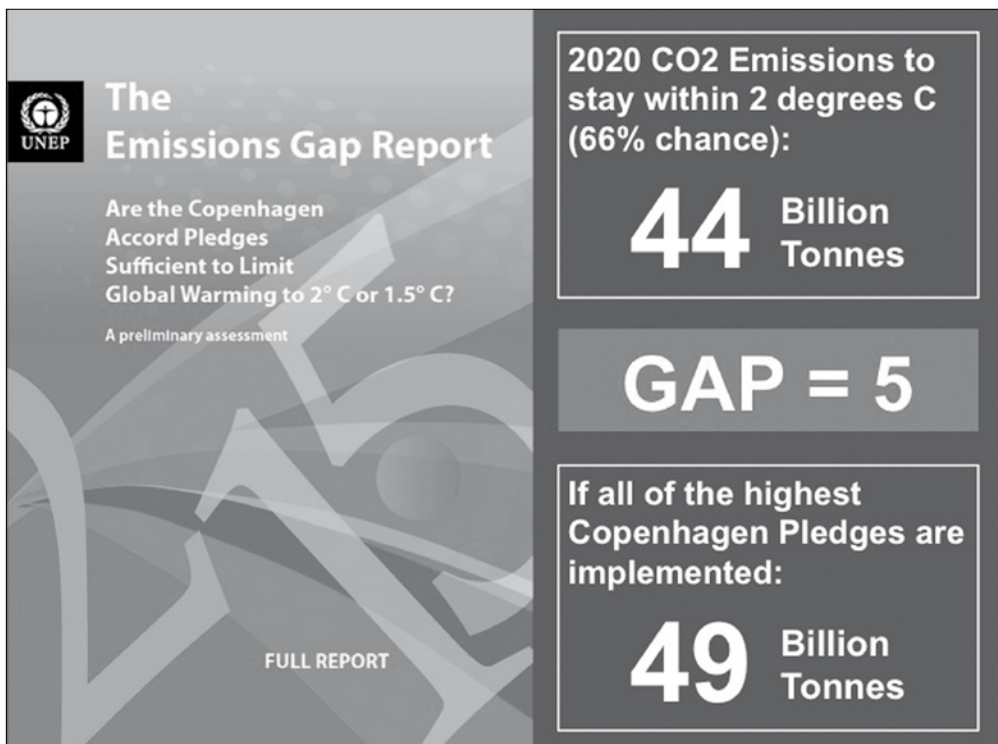


The interesting point is, when I mention this to elderly people like myself *“Look, 50 years from now there will be discontinuities, we won’t be here.”* Many good friends would look at me and say *“Yuan, it is too late, what we are doing? We do not have hope. We won’t be here anyway, so why do you worry”*. Recently when I talk to young people I have to tell them *“Do not trust those people who will not be here 50 years from now. You have to take the fate of humanity into your own hands, especially the political domain. Every four years people change. They never worry about 10 years not to mention 50 years ahead. Many of you sitting there will still be here 50 years from now.”*



Just look at the summary of floods per decade. In America, from the decades of the 50’s, 60’s, 70’s, 80’s, 90’s and 2000, the number of floods is going up. Accompanying the flood is a drop in land surface. In Europe, Africa and Asia, the trend is the same and this is just up to 2000. If we include the data up to 2010, the bars will go up and up and will shoot the roof. And when I talk about this, a friend from Australia once told me ten years ago *“If you worry about nuclear holocaust you should come to Australia. It is the best and safest place when it comes to nuclear holocaust and floods. Everywhere there is flood except in Australia.”* And

yet, two years ago floods covering an area the size of France and Germany combined swamped a beautiful village in Queensland which could not even withstand 3 meters of rain pouring down for 3 days with hundreds of people losing their lives overnight. Australian officials call this “A disaster of biblical proportions.” Of course I don’t have to tell you about the floods in Thailand, it is all over the newspapers. These floods are exactly in accordance with the theoretical model that people predict when you let the temperature rise to 2°C and extreme weather events will increase 3 times because of the fluctuations. The problem is, we are not doing enough.



In COP 15 during the Copenhagen meeting, countries made pledges on CO₂ emission targets and promised that they will do this and they will do that. If in 2020, CO₂ emissions stay within 2°C, there is 66% chance the CO₂ emissions will not go beyond 44 Billion Tonnes. And if all the highest Copenhagen pledges are implemented, CO₂ emissions will reach 49 Billion Tonnes and we will have a gap of 5 B Tonnes. Today, if we look at the levels of Carbon Dioxide concentration, it is around 395 ppm and it is increasing 2 ppm per year. Thirty years from now it will likely be 450 ppm and the temperature will rise 2°C.

It is interesting to note that the UN prediction, according to past scientific record, that the population yesterday reached 7B, and by 2050, 9-10 Billion. They also predict that people in all countries will want to improve their diet, and crop requirement will increase 80% by 2050. But we all know that with climatic change, productivity is going down. And if we have to increase food production by 80%, scientists will raise this 80% by going through another green revolution. But no way! Nobody in the western world would want to take on the problem of population explosion. If you look at Northern Europe, Japan and Taiwan, population is not growing. So they spend money to produce babies at the same time they want you to control your population. We cannot do that, there is some hypocrisy in there. So, together, we have to face all those problems.

As temperature increases, another thing that will wipe us out is the disappearance of some of Nature's workers. One third of the food we eat worth over



USD 200 billion is pollinated by wild insects. Many of us still remember in recent years, the declining population of bees and butterflies so

that fruit producing places have suffered from the lack of pollination. As National Geographic shows that in China's Sichuan province, pear production has gone down as bees disappeared. The farmers, failing to get government support, use step ladders to climb the fruit trees and hand pollinate the blossoms flower after flower, whereas, before, pollination was done by bees free of charge. And in fact nature service produces approximately twice as much GDP as human society is producing and as soon as biodiversity disappears, human society will disappear. So we really have to wake up.

It is time for us to wake up and accede to the fact that our world is overdeveloped. It is overdeveloped in its entirety. But this is something that my African friend does not want to hear. He would tell me, *“Prof. Lee, don’t say that. We are miserable and we have to develop. If you say we are really going to die – we die together.”* I said, *“no! no! we don’t have to do that if we can reduce the per capita production of CO₂ to 3 tonnes rather than the current 5 tonnes.”* The USA produces 20 tonnes per capita, the rest of Europe and France, Germany and England 9 tonnes while Taiwan, 12 tonnes which is very bad. We should go down to 3 tonnes by scientific or many other means like social determination. If you look at Africa, it is producing less than 0.5 tonnes so if we have only 3 tonnes global production of CO₂ Africa will have 6 times more energy to spend. And if you have 6 times more energy to spend and use your current science and technology to build your society, you can build a wonderful society. Then my African friend would say *“Prof. Lee, I do understand what you are saying and I agree if we move in that direction.”*

So if we agree that we are overdeveloped, we have to find alternative ways of development. We really have to do that and do it fast. Consuming much Energy and plenty of materials is not the way to develop especially for those countries which are not yet overdeveloped. The important thing is, we have to go back to sunshine and give up on fossil fuels, but that would take time.

If you look at the Earth, when the solar system was formed, the Earth inherited the energy in two forms. One is in the molten form at the core of the Earth which has very high temperature and moves the continental shelves. The other energy left behind was in the elements like Uranium which we can use as source of energy. How to use this energy is one thing. But large amount of energy is coming from sunshine. Sunshine transfers enough energy for human society in one hour. It means that if human society uses this energy for an entire year, it is only equivalent to the sunshine transmitted to the surface of the Earth including oceans. It means that sunshine provides us about 10,000 times energy we need. If research and development will focus on harnessing the energy of sunshine, I am sure 50 years from now, we can more or less depend on sunshine to provide all our energy needs. Human society deviated from sunshine only 250 years ago, after the industrial revolution. So we should be able to do it.

It is important that the application of science and technology should have the community in mind and not for individual consumption. I think we have to change, because there are now too many people on earth. We also have to respect culture and tradition. Our ancestors who lived thousands of years before lived in better harmony with nature.

But the important thing is we have to engage in collective conversations and shared scenarios. How can human society move? As I have said, with 7 Billion people consuming too much resources and polluting the Earth, we cannot go on? How should we move then? Twenty years ago some leaders in China believed that the automobile industry is the locomotive of economic development as shown by the history of the 20th century, but that is not good for the 21st century anymore. If everyone in China wants to drive the automobile, there is no way! Can China follow the footsteps of America? They get Americanized to a great extent. But that is not really a good way.

We are also seeing that human society has become globalized in the sense that everyday thousands of planes and people traverse the skies, and innumerable goods cross the seas...the scourges of diseases and environmental problems do not respect national borders. But many people say Globalization is really a game for the rich people to use the entire world as a stage and not really for the common people. Eight years ago, the Science Minister of Japan, Mr. Koji Omi, Founder of Science and Technology in Society Forum said and I quote:

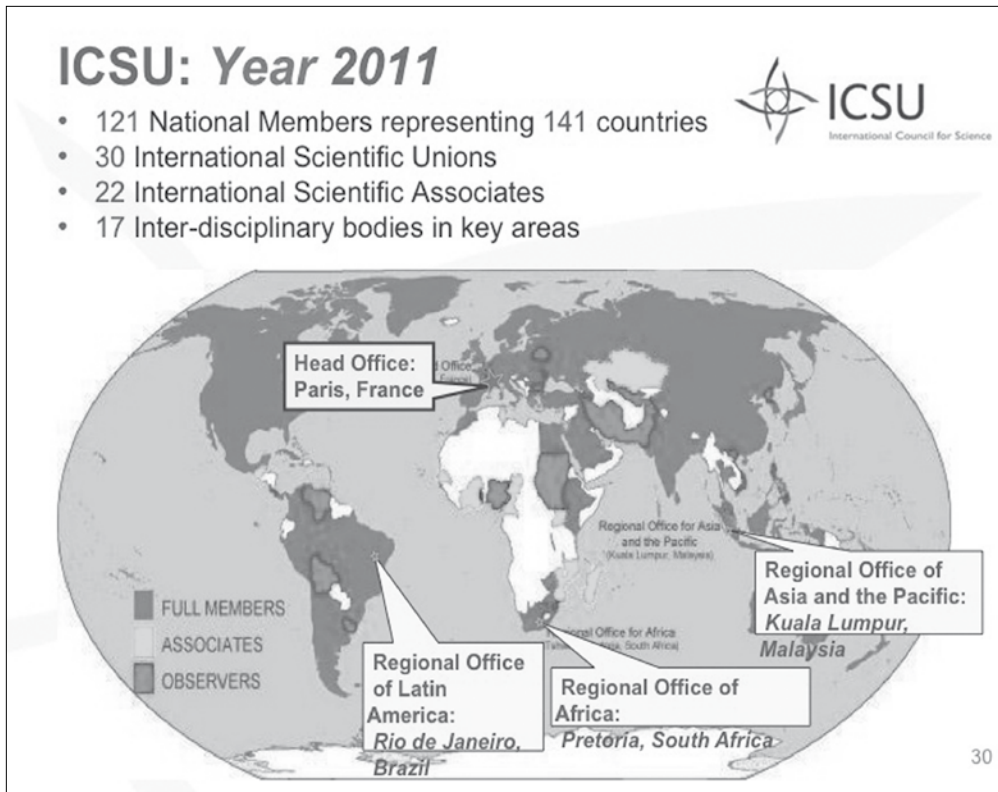
Today's problems are global and cannot be solved by any single country or by scientists alone. Boundaries between nations are merely lines on a map; nature makes no such distinctions. We should think of ourselves as members of humankind whose very existence will be at risk if we do not live in accordance with the principles of Mother Nature.

He was already somehow pointing out that we have to work together. But the way we work together, nation-based competition or nation-based collaboration, is not really good enough. We know that every year, if we sum up each country's expenditures on defense, we spend \$1 trillion to prevent enemies from crossing our borders. In COP 15 they were discussing of transferring \$100 billion which is only 1/10th of the \$1 trillion spent for defense, for programs to mitigate climate change. Nation state-based operations are focused on guarding our borders and providing security against terrorists, but what we are seeing now is that our enemy is coming from the inside not across the borders.

And one other thing we should be concerned about is the worsening disparity between the rich and poor. In the Asian region, it is interesting to note that countries attract investors to put up companies giving them cheap land, cheap energy, water and made tax free for the next ten years. But the effect is only widening the disparity between the rich and poor and this is even true for countries like India and China where despite the presence of billionaires we still see a "world of widespread poverty, disease, illiteracy, unemployment and inequality will never be safe." And again if we look at the money spent to defend the border of every country, what are we doing in global warming or biodiversity loss? Those are across the borders and nation states

cannot even tax the companies which went out and the border problem we are facing is happening all over.

So we have to look at the Earth from its entirety. The Earth does not have borders and one day we might see nation states disappear and the idea of the so-called globalization might not even be there anymore. Therefore, we have to move.



We have an organization called the International Council for Science (ICSU) which has the vision of promoting international science for the benefit of societies. We have 121 national members representing 141 countries, 31 international scientific unions, 22 international scientific associates and 17 interdisciplinary bodies in key areas. But still, we are not yet really international. We are still nation state based. So every time we try to do something and a scientist would agree, when he returns to his home country he is asked one question: Is that going to help national competitiveness? And this contrast between national competitiveness and the desire of solving problems has been a concern. As I said, earlier, the too many people consuming too many resources and producing too much waste and greenhouse gases certainly will wipe us out from the surface of the earth, so we really need to take one good quick action.

The International Council of Science is working together and, hopefully, next year in 2012 the RIO + 20 meeting in Brazil, scientists could give better advice to the politicians on how to move. I do believe that we have to come to an international agreement and convince people that if we want to change, we have to spend some money, some GDP into reforestation or subsidize some of the renewable energies, because these will cost money. Do not think that if we keep on saying green chemistry, green economy, green energy, things will happen, they will not happen; and if they are to happen the transformation has to happen very quickly. Things are very serious.

Every time I talk about relation between human society and sunshine, human society and nature, I often recall the writing of a Japanese comparative literature master on planetarianism and I would like to end this lecture with the following quote:

“Literature and Literary Studies now have one basis and goal; to nurture our common bond to the planet; to replace the imagery of exclusionist familialism, communitarianism, nationhood, ethnic culture, regionalism, globalization or even humanism with the ideal of planetarianism. Once we accept this planet-based totality we might for once agree for humanity to devise a way to share with all the rest of those public spaces and resources...”

.....and unless we learn how to work together we have no future. We cannot continue to develop the way we are currently developing because the earth's resources are finite. We must learn how to work together as ONE COMMUNITY, ONE PLANET and there is not much time to waste. We really need social transformation. And so I hope this meeting on Ethics will lead us to new grounds, and hopefully, we will learn to work together quickly.

Thank you very much for your audience.■



Prof. Yuan Tseh Lee, Ph.D. was the first Taiwanese Nobel Laureate, who won the Nobel Prize in Chemistry in 1986, along with John Polanyi and Dudley Herschbach, “for their contributions to the dynamics of chemical elementary processes.” Lee’s particular chemistry work was related to the use of advanced chemical kinetics techniques to investigate and manipulate the behavior of chemical reactions for relatively large molecules using crossed molecular beams. Prof. Lee served as the President of the Academia Sinica of the Taiwan (ROC) from 1994 to 2006. Presently, he is the President of the International Council for Science (ICSU).