# IGCS BULLETIN

## From the Editors' Desk

Dear Colleagues,

Since our last bulletin in April 2012, IGCS has grown further and we are now happy to have Sibylle Petrak, Visiting Professor for Sustainability and Energy, as part of our team. Ms Petrak joined us in April and has now settled in the IIT-M campus and has her office in the MSRC Building.

Kristin Steger and Peter Fiener celebrated the completion of one year at IGCS and survived their first searing summer in Chennai. Despite the heat, our fieldwork at the Thimmapuram Lake close to Krishnagiri progressed. For this, we thank all our PhD and Masters students and Project Staff for their engagement.

The next important event is already round the corner. The **IGCS Summer School** at the TU Berlin in July followed by our first Steering Committee Meeting in Germany.

Apart from IGCS News, this Bulletin also has two interesting features. The first is a comprehensive view by Sudhir Chella Rajan, our Centre Coordinator, on the actual status of global sustainability. The second is a short report focusing on the carbon footprint of IIT Madras, a student project carried out during our last Winter School.

We hope you enjoy reading our Bulletin and we are happy to receive any feedback.

Yours sincerely,

Peter Fiener, Kristin Steger & Sibylle Petrak

INDO-GERMAN Centre for SUSTAINABILITY

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## Contents



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### *IGCS Lecture Series*

*Our colleagues, Dr. Brajesh Dubey (University of Guelph; 09/08/12), Dr. Karl Schneider (University Cologne; 13/08/12), and Dr. Lars Tranvik (Uppsala University) are expected to visit IGCS in August. They will all present lectures as part of the IGCS Lecture Series.*

### *Sustainability Conferences*

### *Select International Conferences focusing on Sustainability*

***9–10 July, 2012***

International Summit - ***Waste to Energy***.
NDCC II Convention Centre, NDMC Complex, New Delhi.
Details at
*http://w2e.missionenergy.org/*

***8–19 October, 2012***

***XI Meeting of the Conference of the Parties (COP 11)***
Hyderabad, India.
Details at
*http://www.cbd.int/cop11/*

***13-16 May, 2013***

**8th Annual International Symposium on Environment**
Athens, Greece. Details at
*http://www.atiner.gr/2013Conferences.htm*

# IGCS News

## *IGCS Lecture Series*

The IGCS Lecture scheduled on August 27, 2012 will have Dr. Sibylle Petrak present *From Solar Resource Assessment to Biophysical Economics*.

As always, the lecture will take place at 4 p.m. in the Visveswaraya Seminar Hall at the Civil Engineering Department of IIT-M. Further details and an invitation will be sent via the IITM 'Announce' mailing list. For those not on the IIT-M list but interested in receiving details and invitations for the lecture series please send an e-mail to fiener@igcs-chennai.org

## *Steering Committee Meeting*

Prof. Behrendt (Area Coordinator Energy) will host the IGCS Steering Committee Meeting this time at our partner university TU Berlin.


*Banner of the Indo-German Short Term Training Programme*

## *IGCS Conferences – Workshops*

***23-27 April 2012, IIT-Madras***

### *Large Scale Grid-Connected Solar Photovoltaic Power Plants*

In view of India's ambitious solar plans at the national and state level, the training programme was jointly organized by the Electrical Engineering Department of IITM, Renewables Academy (RENAC, Berlin), and the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) with the goal of transferring required knowledge.

Technical and financial project management, feasibility studies, plant layout, and business model development were some of the areas covered by the lectures. They also focused on specific Indian challenges concerning the development of photovoltaic standards for Indian grid conditions, safety issues under islanding operation (when the grid fails) and operational aspects for typical Indian weather conditions of high temperature, high humidity, and high dust load.

Practical advice was provided for cleaning solar panels, designing power inverter housing, handling operation and maintenance and after-sales service. Technology-specific advice for thin-film modules with regard to humidity-caused delamination and mechanical breakage during transport and construction were also made available.

The lectures were complemented by a visit to the Photovoltaic Training Laboratory at the Central Electronics Centre. Here the participants gained hands-on experience with string design, cable sizing, module shading, Photovoltaic trackers, and remote monitoring.

Many of the participants expressed gratitude during the closing session for the opportunity to take part in such an exciting workshop. India is now poised at the pioneering frontier for Solar Photovoltaic installations and the excitement was palpable among all workshop participants –engineers, utility experts, contractors, and even the bank loan officers.

## *Video*

1 MW Solar Power Plant (RL Clean Power Marakkathur) commissioned and connected to the grid: *http://www.youtube.com/watch?v=ZdPVFJi6Qrw*

## *Sustainability Literature Updates*

### *Literature*


Barnovsky A.D. et al. 2012. *Approaching a state shift in Earth's biosphere.* **Nature** 486, 52–58.

Cardinale B.J. et al. 2012. *Biodiversity loss and its impact on humanity.* **Nature** 486, 59-67.

Maslin M. & Austin P. 2012. *Uncertainty: Climate models at their limit?* **Nature** 486, 183–184.

Brito L. 2012. *Analyzing Sustainable Development Goals.* **Science** 336. 1396-1398.

Leach, M., J. Rockström, P. Raskin, I. Scoones, A. C. Stirling, A. Smith, J. Thompson, E. Millstone, A. Ely, E. Arond, C. Folke, and P. Olsson. 2012. *Transforming innovation for sustainability*. **Ecology and Society** 17(2). 11.

Auffhammer, M., V. Ramanathan, and J. R. Vincent. 2012 *Climate change, the monsoon, and rice yield in India*. **Climatic Change** 111(2). 411-424.

# Features

## *The Tortuous Road to Sustainability: An Assessment for Rio+20 and Beyond*

**Sudhir Chella Rajan**
*Professor and Head, Department of Humanities and Social Sciences, IIT Madras*
*IGCS Coordinator*

In June this year (at the time of this writing), world leaders are meeting to commemorate and review progress 20 years after the international community made a commitment to shift course through technology and institutional change to reduce environmental degradation and build cooperation for equitable access to resources. Sadly, there seems little to celebrate, given broken protocols and fragmented action at regional and local levels. Yet, it is also unmistakable that the environment is no longer a fringe concern but an existential and material question of fundamental importance concerning human survival.

Consider the balance sheet. There is widespread evidence that the biodiversity of species and the services associated with healthy ecosystems are both rapidly declining across virtually all the major biomes of the world. Local pollution and levels of degradation in the major emerging economies of the world have become so intense as to be serious decelerators on development – estimates are that environmental pollution costs about 6 and 10% of GDP in India and China, respectively (Managi and Jena 2008; Wen and Chen 2008). Freshwater sources are under severe threat and, most despairing of all,

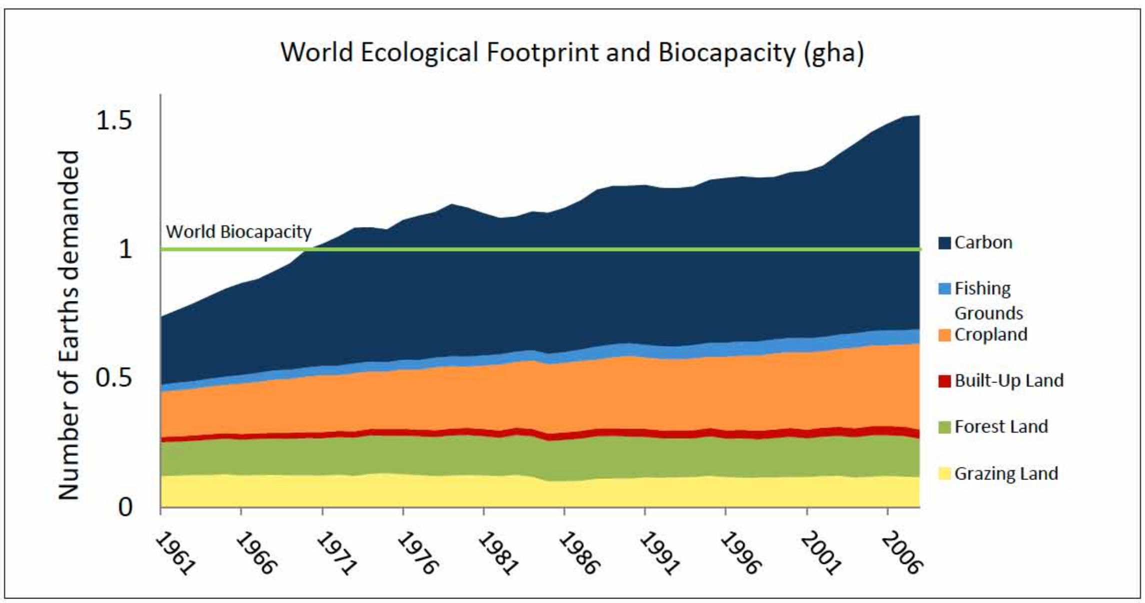


*Figure 1: Carbon is overwhelming the Earth's biocapacity. Source: Global Footprint Network (2012).*

climate change threatens to greatly exacerbate these conditions while also generating new problems, such as rising sea levels, extreme weather events, desertification and potentially threaten major regional climate systems such as the Indian monsoon.

This year's event in Rio may well turn out to be the tipping point in terms of humanity's ability to sustain itself, i.e., provide for future generations the same resources and opportunities that current generations already have, while also enhancing equity, reducing poverty and generally creating better conditions for human flourishing. In what follows, I try to lay out some of the challenges to achieving sustainability, seen specifically through the lens of climate change. I focus on climate change, not because it is the only marker of environmental concerns, but because addressing it will inevitably impinge positively upon a very wide range of issues that already threaten the planet. Climate change is therefore a reasonably good proxy for a broad spectrum of sustainability concerns faced by the planet (Fig 1).

By way of context, the scientific consensus is that there is a two-thirds chance that we can avoid global average temperatures exceeding pre-industrial levels by 2 degrees – a critical threshold for sustainability – but only if we limit anthropogenic additions of greenhouse gases during the next four decades to the equivalent of about 750 billion tonnes of carbon dioxide (Fig 2). Seen in the light of current global annual emissions of about 35 billion tonnes, with recent annual growth of about 3%, this target seems daunting enough. But when considered against current political, ethical, technological and financial challenges, the concerns are considerably more serious.

### *Political Barriers*

First, the political impasse with regard to concerted international action has to do with conflicting understandings of the obligations and claims of different stakeholders. The United States and China, followed by India and Russia, are the largest annual emitters of greenhouse gases, but Europe and the United States are responsible for more than two-thirds of the stock of anthropogenic carbon. The latter point is important, because it is the concentrations of carbon dioxide (which stays in the atmosphere for a very long time) that are responsible for warming, not the rate at which it is emitted. A major bone of contention between developing and developed countries has to do with interpretation of Article 3.1 of the United Nations Framework Convention on Climate Change, which states: "The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof."

In the current climate change negotiations, leading up to the annual Conference of Parties in Doha later this year, China, India and many other members of G-77 are insisting that the historical obligations of developed countries not be forgotten in allocating future burdens

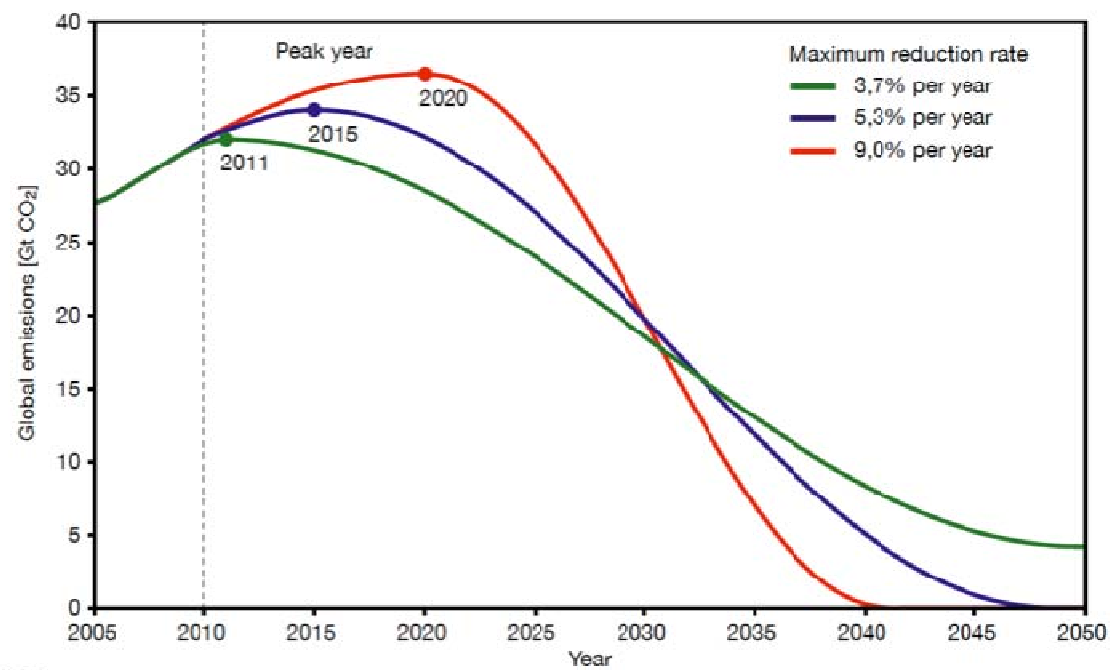


*Figure 2: Global emissions pathways from 2010-2050 to ensure a 67% chance of limiting global temperature rise to within 2 degrees Celsius. Source: WBGU (2009).*

for emissions reductions, whereas the United States as adamant in its refusal to consider them and Europe appears ambivalent but mute on the subject. Instead, the limited common ground has been found around the issue of individual countries setting their own programmes for action, with the hope that these 'pledges' will somehow add up in a meaningful way. Domestic politics within all the major countries also alter these international negotiating positions in a significant way, as was starkly seen in the case of the United States withdrawing from the Kyoto Protocol when George W. Bush became President in 2001.

### *Ethical Challenges*

Second, there are ethical concerns, which are closely tied to these political challenges. Ethical considerations are not merely the musings of academics but are vital for informing policy because they provide reasons for taking one set of decisions rather than another. Cost-benefit analysis, for instance, is one such decision-making tool, which is derived from ethical considerations drawn from utilitarianism. But given that there are many problems associated with it, it is important that a broader set of arguments from political philosophy be deployed in developing policy in any complex domain, and especially so in the area of sustainability.

For climate policy, questions of justice are especially thorny. With more than a third of humanity living close to or in a state of poverty, with limited or no access to clean water, sanitation, electricity services and modern cooking fuels, it is clear that sizeable additional inputs of energy will be required to provide some of these services, particularly in developing countries. Given that the world's energy system is still far from being 'decarbonised', meeting the needs of the world's poor will therefore imply significant additions of carbon to the available budget. And because a large part of the total global carbon budget for a sustainable global climate has been used up already, the poor will have to hope for lower carbon-intensive technologies or forego their chances of getting some of those services. This is the problem of Disproportionate Accumulation, where one group of players has disproportionately used up ecological space and requires remedies based on broadly accepted terms of distributional justice, a subject on which much has been written (e.g., Shue 1999, Vanderheiden 2008).

There is another ethical strand associated with climate change one might term Asymmetrical Impacts, because the poor, particularly those living in developing countries, will experience far worse consequences from climate change than the wealthy, especially those living in the industrialised North (Byravan and Rajan 2010). This could be because of geographic as well as economic reasons. Many developing countries are on small islands or encompass low-lying coastal areas and other regions that happen to be especially prone to natural disasters, which will be exacerbated by climate change. But perhaps more important, they typically do not have the resources to mitigate the effects of climate change by protective measures and extensive insurance arrangements. Indeed, the most vulnerable people will be those who lead subsistence livelihoods in the highly risk-prone areas.

While there are many persuasive ethical arguments for a just political outcome on climate change, they are also quite difficult to sort out, in part because of various philosophical challenges associated with so-called causal versus moral responsibility, assigning liability for greenhouse gases and other forms of radiative forcing than that caused by carbon dioxide, identifying the appropriate agents for assigning responsibility (e.g., countries, individuals, corporations or some combination), addressing responsibility for dealing with so-called climate refugees (an inappropriate term, since the Refugee Convention does not provide legal recognition for environmental refugees; a better characterization is 'climate migrants' and 'climate exiles'), and finding appropriate ways to reduce moral hazard from any ensuing policy (e.g., preventing technology rebound effects through social change relating to consumption). Moreover, as countries increasingly adopt neo-realist positions in their negotiations, ethics is often placed by the wayside, which causes deep cynicism and despair, especially among civil society groups and the poorest developing countries that will be most vulnerable to climate change.

### *Technology Constraints*

Third, there are several technological challenges to addressing climate change, the most significant of which relates to the energy system, which is the dominant source of anthropogenic greenhouse gases. About eighty percent of primary global energy supply is from carbon-intensive coal, oil and natural gas, which have major advantages that are reflected in their low costs relative to the alternatives. These include their abundance, high energy density, ease of transportation and the enormous physical infrastructure that is already in place for their extraction, and conversion to useful forms and delivery (as electricity, petrol and diesel) to devices and systems that are specifically designed to make use of these carrier fuels and themselves make up a huge network and user base.

Among the alternatives, nuclear energy, which has been deployed for nearly 70 years, is not likely to play more than a supporting role in energy supply by 2050, in part because of the substantial costs associated with ensuring safety throughout its life-cycle, the risks of fuel diversion for proliferation and the recurrence of catastrophic accidents such as Chernobyl and Fukushima, which impact its reputation as much as anything else. Similarly, most forms of renewable energy, including wind, solar and tidal power, which all have significant potential that remains to be tapped, are intermittent and cannot therefore be the source of base-load electricity unless there are revolutionary changes in storage technology, which does not seem likely in the near term. Biomass energy, though widespread, is limited by its distributed character and by competition for land used for food, but it is still an excellent source of decentralized energy services and can generate local employment. Improving energy efficiency throughout the energy system will vastly reduce greenhouse gases at low to negative costs, but will only be effective up to a point (Fig 3).

In other domains where technological change is an essential component of realizing sustainable outcomes, there are similar barriers, characteristic of what Thomas Hughes (1993) and others have termed "reverse salients," except that these are rarely as time-critical as in the case of energy technology to reduce greenhouse gas emissions. Significantly, a lot of "technology lock-in" is currently taking place in the energy sector; for example, massive investments are occurring in petroleum, natural gas and, to some extent, coal, which will put in place infrastructure for at least another three to four decades. Reversing some of these decisions will prove costly.

### *Financial Difficulties*

Fourth, financial constraints with respect to climate change are at least as daunting as some of the other challenges outlined above. The International Energy Agency estimates

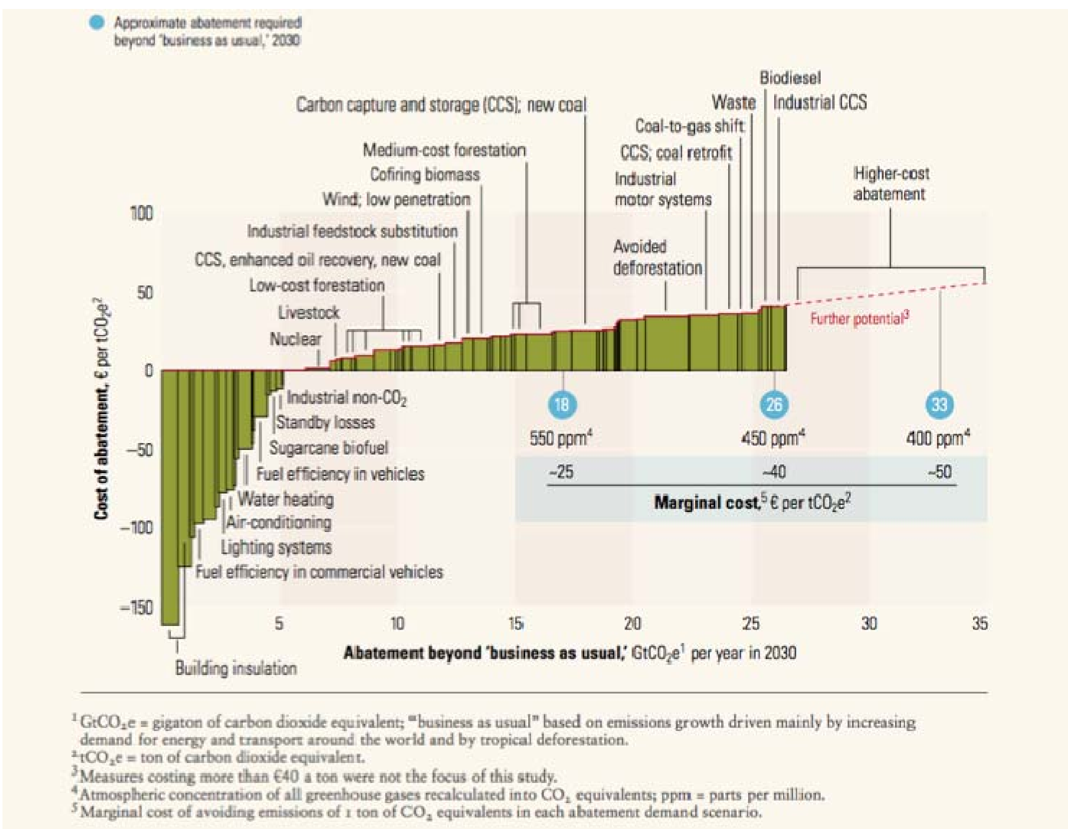


*Figure 3: Marginal cost curve for greenhouse gas abatement. Source: Enquist et al., 2007.*

that US $38 trillion is needed between 2011 and 2035 just to meet projected energy demand (IEA 2011). It is likely that there will be a substantial cost premium on this figure to reduce greenhouse gases, especially to the levels needed for a sustainable planet. The Stern Review indicated that the overall cost of reducing greenhouse gases would amount to about 1 to 3 percent of annual world GDP over a 50-100 year period, but it also used a much higher level of greenhouse gas concentrations for stabilization (550ppm $CO_2$) than is currently considered acceptable (Stern 2007).

Even if these numbers were considered to be a reasonable approximation of the investments needed to achieve a sustainable climate, a major constraint has to do with mobilising the requisite levels of finance, particularly in the early years, to get significant shifts happening in our energy and land-use systems. In the Copenhagen climate summit in 2009, for instance, developed countries aimed to raise US $100 billion per year by 2020 from a wide variety of sources, which were later identified as including carbon taxes, savings from cuts in fossil fuel subsidies, and public and private investments in low carbon infrastructure. Public funding is meant to be additional to existing official development assistance (ODA) and other existing flows to developing countries.

There is currently a stalemate in discussions on climate finance, having to do with differences in interpretation between developed and developing countries; the former believe that private finance should be used to help developing countries make the transition to low carbon economies, whereas the latter argue that additional public financing from developed countries is essential in fulfilling their obligations of “common but differentiated responsibilities” under Article 3.1 of the Convention. To date, very little public finance has actually trickled into climate funds, although some private investments through carbon trading and other mechanisms have been forthcoming. The recent financial crisis has also thrown a major spanner in the works, with both private and public entities showing great reluctance to invest in long-term low carbon projects and programmes.

None of the above challenges are what one might call “gamestoppers,” but they indicate just how tortuous the path to achieving climate sustainability can be. Nevertheless, there are some ways to untangle the Gordian Knot: if a persuasive ethical argument leads to a politically acceptable solution, something that was hinted at during the recent negotiations at Durban last year, then it is very likely that sufficient financial resources can be mobilized quickly to kick-start technology R&D to overcome current challenges and implement policies to reduce greenhouse gas emissions around the world, but in a manner in which people living developing countries can also quickly leap-frog to locally sustainable lifestyles while eliminating poverty. We may only have a narrow window of opportunity to build this optimal pathway, and Rio+20 now and Doha later this year, are two of the key occasions when world leaders can make historic transitions towards sustainability. Whatever happens, there is plenty of work to do for those concerned with the future of the planet.

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# IIT-Madras and its Carbon Footprint

*Report of the IGCS Winter School Student Project at IITM, Chennai*

T. Wolters, S. Schultz, S. Krishnasamy, J. Volkers, L. Hallau

### Introduction

The urgent need to combat climate change in the biosphere is becoming a key determinant of the economic development paths for all nations. Economic growth remains a priority for national governments. However, this growth is increasingly being measured by the effectiveness of the steps taken to protect the environment, including control of Greenhouse Gas (GHG) emissions. As the international community moves towards a sustainable, less carbon emitting world, there is also a need to evaluate the carbon footprint of an institution engaged in sustainable education. Carbon FootPrint (CFP) is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product (Wiedmann & Minx, 2008).

*Table 1. Required data for calculation of carbon footprint*

| Activity Type | Estimated Amount | Unit | Emission factor | CFP factor |
|---|---|---|---|---|
| Electricity | 29.9 | $10^6$ kWh | 1.56 | 46612800 |
| Milk | 484 | $10^3$ l | 0.8 | 605625 |
| Rice | 1040 | $10^3$ Meal | 0.14 | 145600 |
| Meat | 320 | $10^3$ Meal | 1.4 | 448000 |
| Paper | 200 | 500 sheets | 6.2 | 1240 |
| 2-wheeler | 66.8 | $10^3$ km | 0.04 | 2674 |
| 4-wheeler (petrol) | 371 | km | 0.23 | 85 |
| Vehicles admin use | 562.5 | l (petrol) | 2.4 | 1350 |
| Bus | 32400 | l (diesel) | 2.7 | 87480 |
| Domestic Flights | 13440 | Flights | 128 | 1720320 |
| Internat. Flights | 800 | Flights | 1070 | 856000 |

In general, CFP has become an important indicator as most industrialized countries have made a commitment to reduce their emissions of $CO_2$ by an average of 5.2% in the period 2008–2010 with respect to the level of 1990 (Sayigh, 1999). In order to monitor the input and output of GHG emissions ($CO_2$, $CH_4$, $N_2O$, HFCs, PFCs, SF6) carbon is used as a unit to calculate the CFP and an equivalent has been chosen to transfer GHG into carbon units.

*Methodology adopted for the student project*

To calculate CFP, different zones and boundaries had to be set. Primary sources (survey) and secondary sources (literature research, database) were used to measure and calculate different activities. For the survey we focused on the CFP of transport. Since emission factors vary based on distances travelled, we had to split trips as long and short distances by train, domestic and international flights, and behavior of car driving. As secondary source we used data from the IIT-M campus with respect to the consumption by members including staff, faculty, and students, and the energy consumed in terms of electricity, buildings and food.

### Estimation of IIT-M's carbon footprint

To calculate the CFP, we used the emission factors to multiply the amount of activities. For every activity we had the number of the specific carbon footprint which we added to the other numbers and activities. This resulted in a total amount of 50000 t CO2e yr-1. Table 1 shows the different activities with their specific emission factors and CFP factors, respectively. The data source varies according to activity: data on electricity we got from the electricity bill, amounts of food we received after surveying the single canteens on the campus. Concerning the transport of cars, bikes and buses within the campus there was a statistical letter of daily entry and exits of the vehicles. Plus, the travel distance on the campus was estimated. The information about the flights was taken directly from a conducted survey among faculty and students, whereas all non-private flights of faculty and students visits to parents were taken into account. As shown in Fig. 2 electricity has with 92% by far the biggest CFP on the IIT-M campus,

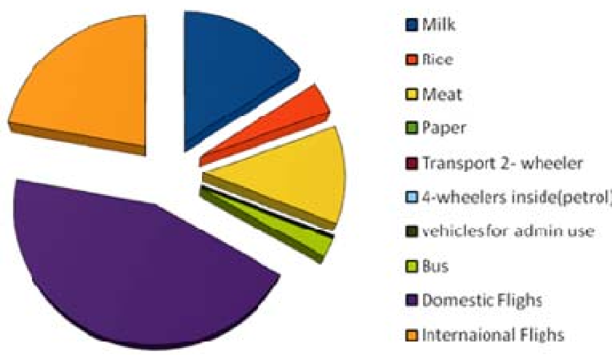


*Figure 1: Relative CFP (without electricity) of different carbon sources at IIT Madras.*

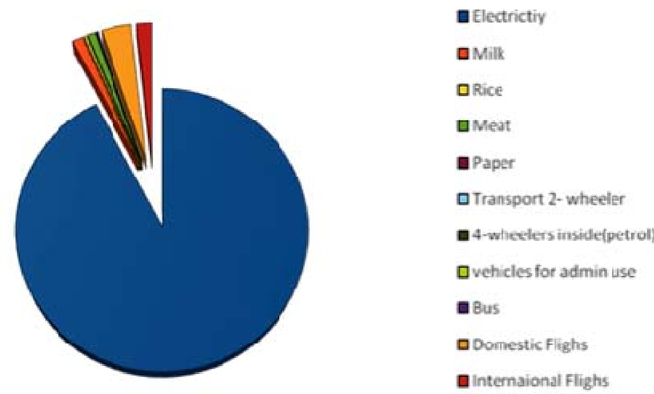


*Figure 2: Relative CFP of different carbon sources at IIT Madras.*

whereas the transport of vehicles within the campus is negligible, the flights (5%) have to be recognized as well as meat and milk consumption (Fig. 1).

### Implementation strategies for a carbon reduction plan

- Demonstrating respect for nature and society and agreeing that sustainability considerations should be an integral part of planning, construction, renovation and operation of buildings on campus.
- Ensuring long-term sustainable campus development; campus-wide master planning and target-setting should include environmental and social goals.
- Aligning the organization's core mission with sustainable development, facilities, research; education should be linked to create a "living laboratory" for sustainability.
- Sustainable Building Design
- Waste reduction

A research institute such as the IIT should take the challenge and be a role model in working to create a sustainable future, by finding and also implementing solutions on how to face climate change. In order to do this, a management plan should be prepared, focusing on the implementation of actions on GHG reduction, interdisciplinary research on energy efficient use of electricity, alternate energy, and land use systems.

### Discussion

The case study about the Carbon Footprint of the IIT-M campus illustrates the proportion of emission sources. Although it is just a rough estimation, you can easily see that electricity usage is responsible for the highest amounts of CO2. It may seem easy to start reducing emissions by creating awareness of the main sources: use of air conditioners and fans. Through our survey we learnt that awareness already exists in people's mind and that it has more to do with restricting their own behavior and change their way of living such as switching off the A/C or a light while leaving a room. In these situations they don't think about the carbon footprint.

The awareness of $CO_2$ emissions caused by airplane journeys exists, but the decision to avoid flights and use the train is quite difficult, especially in a huge country like India. Professors would prefer to travel by train or even to do an Internet conference instead of travelling. However, it is almost impossible to replace a 2-hour flight to Delhi by a 36-hour train journey.

For a reduction of $CO_2$ emissions not only is more awareness about climate change and carbon Footprint necessary, but also a tool that leads to a change in behavior, e.g., the acceptance of a meeting via internet or paying privately out of one's own pocket for using an A/C in the office.

There is still a long way to go and many tonnes of $CO_2$ will be emitted before people notice that it is time to change their behaviour.

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# IGCS Research

After a first field trip in February the activities in the framework of the IGCS project *Effects of soil organic carbon redistribution upon green house gas fluxes from terrestrial and aquatic ecosystems in a small agricultural catchment in South-East India* in the Thimmapuram catchment (Fig. 1) were extended.

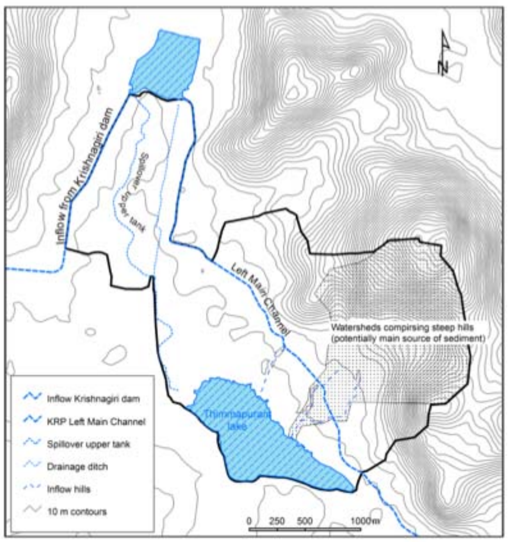


*Figure 1: Thimmapuram catchment*

During the April and May field trips we collected up to 150 soil samples and resampled lake sediment and water. To carry out the laboratory analyses, e.g., measuring methane production from water samples, determining carbon and nitrogen content in sediments and soils, are under progress the facilities at the Environmental Water Resources Engineering (EWRE) Division, and in the Biotechnology as well as Chemical Engineering Department of II-T Madras were used.

A part of the analyses will be also carried out at the IGB in Berlin together with Dr. Premke, who visited IGCS in February 2012. This cooperation will also allow IGCS staff to travel to Berlin and get insights into new techniques, which will also be established at IIT-M.

Besides sampling, a number of in-situ measurements were performed. These were mostly used to determine water quality parameters as well as soil respiration under different land use.

*In-situ soil respiration measurement using a PP-Systems respiration chamber together with field infrared gas analyser*

Apart from the small-scale study at the Thimmapuram lake a second water related project of IGCS focuses on climate and land use change effects on the water resources in the upper Penniyar catchment.

In cooperation with K.P. Sudheer and P. Fiener from IIT-M, the IGCS scholar, A. Strehmel, will present first modelling results at the upcoming Soil and Water Assessment Tool (SWAT) Conference, July 16-20, 2012, New Delhi. At the same conference, the IGCS scholar, F. Wilken, will also present a remote sensing based analysis of land use change in the catchment (1990 to 2011). This study is being done in cooperation with the University Cologne.

# IGCS Courses and Faculty

## *IGCS Teaching*

The **IGCS Summer School** *Meeting the Challenges of Advanced Energy Systems for the Future* at the TU Berlin from 08-16 July 2012 will be hosted by Prof. Behrendt (Area Coordinator for Energy) and funded by IGCS. Several German experts as well as several faculty from IIT-M will participate in the teaching activities.

In August, a Summer School focusing on integrated water resources management in rural areas, which is organized by CAU Kiel, EWRE and IGCS will be held at IIT-M (Aug. 13 - Sept. 2 2012).

In addition to the Summer Schools, the visiting faculty at IGCS will teach several courses during the next term focusing on different aspects of sustainability:

- Sustainability in Environmental Biotechnology - Kristin Steger.
- Environmental and Resource Economics, Environment and Society - Sibylle Petrak.
- Sustainability in River Basin Management - Peter Fiener.

## *IGCS Staff & Scholars*

In June a new IGCS Fellow, Tom Gottfried from the TU Munich joined our centre. He will work with us in the field of land use and soil for the next three months.

In May, we had to bid a fond farewell to Teresa Warnk who worked with us over the last six months.

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