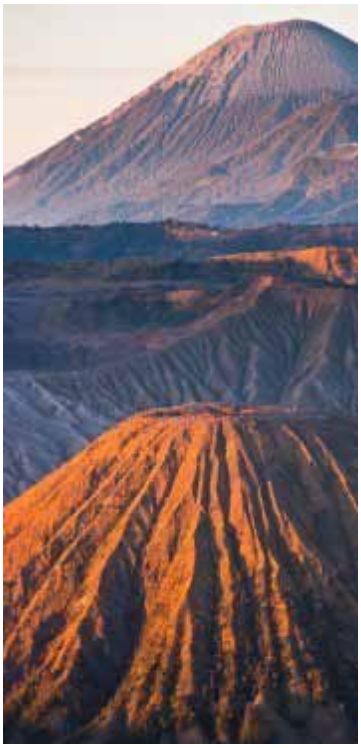
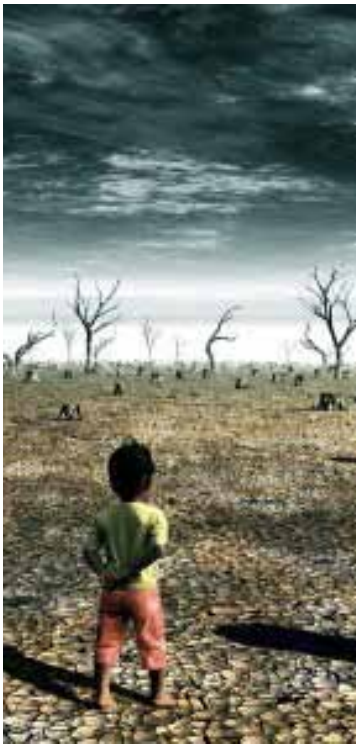
STARVING TIGERS?

Impact of Climate Change in South East Asia

Workshop Report



26-27 January 2010
Singapore

EARTH OBSERVATORY OF SINGAPORE
An institute of Nanyang Technological University

S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
A Graduate School of Nanyang Technological University

STARVING TIGERS? IMPACT OF CLIMATE CHANGE IN SOUTH EAST ASIA

REPORT OF PROCEEDINGS

ORGANISERS

EARTH OBSERVATORY OF SINGAPORE

AND

THE RSIS CENTRE FOR NON-TRADITIONAL SECURITY (NTS) STUDIES

26-27 JANUARY 2010
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This report summarises the proceedings of the workshop as interpreted by the assigned rapporteurs and editors of the RSIS Centre for NTS Studies. Participants neither reviewed nor approved this report.

The workshop adheres to a variation of the Chatham House Rule. Accordingly, beyond the speakers and paper presenters cited, no other attributions have been included in this report.

Executive Summary

The Copenhagen Summit in December 2009 failed to yield a concrete, politically-binding agreement among states to reduce carbon emissions in order to mitigate climate change. This is so despite the widespread recognition of the potential risks of climate change. The lack of consensus is due to diverse and often conflicting national interests and priorities. With an international collective action deemed virtually unlikely, the onus is on states to implement national and regional adaptation measures to combat climate change.

Phenomenal trends associated with climate change are sufficient cause for concern and prompt action by states. Sea level rise is projected to increase, and if uncertainty factors were incorporated in the estimates – such as stored carbon and water vapour content – this might even be higher than expected. Given the rather imprecise science of estimating sea level rise, it is prudent to include these uncertainty factors in order to provide a clearer, more accurate picture of future sea level rise scenarios that can facilitate national or collective adaptation measures.

In fact, climate change and its impact had its roots in the ancient times. Scientific studies performed show a clear relationship between alterations in climatic patterns and socio-economic-political upheavals in the ancient dynasties of China, for instance. Periods of high rainfall helped in the national prosperity of the Northern Song Dynasty, while severe droughts were found to be the cause of subsequent political upheavals in the Tang, Yuan and Ming Dynasties. Also, it has been shown in studies that changes in climatic patterns in one region could have potential spillover effects onto another, with potential ramifications on interstate relations.

Fast forward to contemporary times, the impact of climate change on national well-being cannot be underestimated. The world is already experiencing rapid population growth (in Southeast Asia especially) and this creates a strain on existing food supplies. Climate change can potentially aggravate this situation by affecting agricultural growth. Using modern modelling techniques, it has been shown that the world will suffer a loss of 300 million metric tonnes of grain production by 2050 compared to 100 million metric tonnes in 1995 as a result of climate change-induced changes that lead to increased temperatures that inhibit proper plant growth, affect rainfall patterns and inundate coastal croplands as a result of rising sea levels. This issue is particularly pertinent for agriculture-dependent Southeast Asia.

It is plausible to adapt to climate change conditions in order to safeguard food security. However, such adaptation measures carry with it additional costs to be factored into food production. As a result, rising grain production costs may potentially impinge on less-endowed, less-developed countries in Southeast Asia. Nonetheless, adaptation measures in agricultural production, such as research and development (R&D) – in particular genetically modified organism (GMO) techniques – as well as infrastructure enhancement, constitute an essential and crucial means to overcome the potential food security problems that can be brought about by climate change.

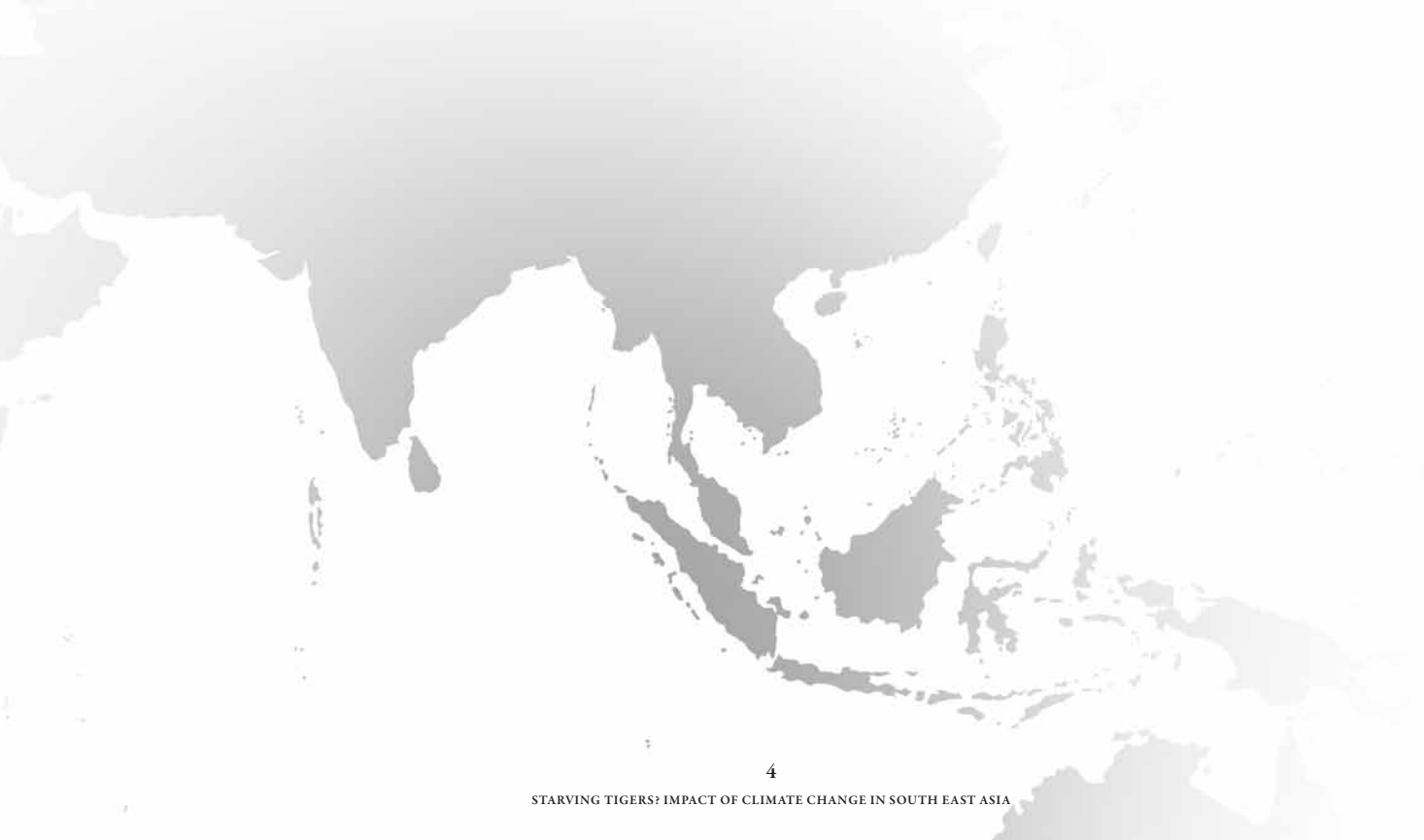
Another area of food security concern with regard to climate change impact is the marine fishery and aquaculture sectors. Fish is a key source of animal protein for the Southeast Asian populations and serves as a vital source of economic livelihood. In recent times, overfishing has led to a steady decline of capture fish stocks. Climate change-induced ocean acidification brings about adverse impact on the marine ecosystem and thus places further stress on the sustainability of fish stocks. The countries most vulnerable to climate change-induced impact on fish stocks are found to be those which are the least developed, in Southeast Asia. Rising populations in this region, coupled with human- and climate change-induced impact on capture fish stocks, can bring about likely food security risks. A range of adaptation measures, such as aquaculture, may help alleviate some of these problems in the foreseeable future.

With problems associated with sea level rise and climate change-induced food security woes comes the potential risk of increased environmental migration as a form of adaptation means undertaken by affected peoples. Poverty constitutes a central issue revolving around population vulnerability to climate change and environmental migration patterns. The huge rural/coastal populations in Southeast Asia are particularly exposed to such dangers. To date, however, lack of data and research capacity hamper adequate preparations against such contingencies in the region. This is further compounded by the paucity of regional and international cooperation on migration issues in general.

As such, in view of the phenomenal patterns in climate change, the ensuing potential security risks and the dim prospects for an internationally-agreed framework of cooperation, it becomes imperative for individual countries to exercise initiative in implementing viable adaptation measures. However, due to the complex range of uncertainties (such as the contestability of scientific methods used to project climate change impact estimates) found in climate change scenario projections, it might be more realistic for policymakers to focus on short- and medium-term adaptation. In addition, climate change adaptation and mitigation not only have to involve government policymakers and the private sector, but non-governmental organisations (NGOs) as well.

The translation of scientific knowledge to actual policymaking also deserves greater attention. There is a need to bridge knowledge with policymaking, in order to ensure coherence between scientific evidence and correct policy actions. Also, the existing knowledge base on climate change is huge and expanding, thus further complicating the bridging of scientific knowledge with the policymaking process. The academe and policymaking circles need to constantly revisit existing and new data on climate change and seek ways to exploit them fully to formulate and implement suitable measures. However, this is often easier said than done.

Finally, there is an acute need for Southeast Asia – identified as one of the regions most vulnerable to climate change impacts – to improve upon national and regional capacity-building. Due to socio-economic disparities, countries in the region are not all adequately prepared against the impact of climate change. Intra-regional cooperation has to be enhanced since the adverse impact of climate change will not be merely confined within national boundaries, but will have potential transnational spillover effects. Regional capacities, especially in the realm of research and data collection, are especially crucial priority areas that need to be embarked upon.



Conference Proceedings

Welcome Remarks

Professor Kerry Sieh
Director
Earth Observatory of Singapore
Nanyang Technological University

Professor Kerry Sieh extended a warm welcome to participants in the workshop. In his welcome remarks, Professor Sieh noted that a paradigm shift is needed for contemplating contemporary and emerging world developments. In particular, he referred to the impacts of climate change as well as other pressing issues, such as rising population levels and the scarcity of resources.

The workshop focused particularly on food security and migration issues in the context of climate change. However, as Professor Sieh pointed out, there remains a lack of understanding among various disciplines regarding the nature of climatic and geological phenomena, and its implications for policymaking. As such, this workshop essentially seeks to address questions about the impact of climate change in Southeast Asia by bridging the gap between natural and social science scholars, policymakers and business experts by bringing them together on a common platform to discuss these pertinent issues.

Lastly, Professor Sieh assured participants that abundant time would be allocated for questions and answers, and remarked that he looked forward to an 'aggressive discussion' among the participants.

Starving Tigers? COP15 Outcome

Mr Andreas Schaffer
Senior Principal
Monitor Group

Mr Andreas Schaffer set the stage for this conference with an overview of the outcome of the Copenhagen Summit in December 2009. Besides the non-binding and tentative nature of the Copenhagen Accord, which is due to be implemented by 2015, one of the other more defining features of this summit, he pointed out, has been the lack of national commitment to carbon emission targets, notwithstanding the broad global recognition of the dire consequences of global warming. Moreover, various countries worldwide have different standards of measurement, reporting and verification guidelines governing carbon emissions and mitigation actions.

Not all is gloomy, however, as the Conference of Parties generally agreed during the summit that the forestry sector constitutes a key component for climate change mitigation. The immediate establishment of a mechanism, including Reducing Emissions from Deforestation and Forest Degradation (REDD)–plus– to enable the mobilisation of financial resources from developed countries – was advocated. To that end, an additional fund of US$30 billion has been earmarked for the period 2010-12 for developing countries to carry out mitigation policies through REDD-plus, technology development and transfer, as well as capacity-building measures.

Mr Schaffer also pointed to the pledge by developed countries to commit to mobilising US$100 billion by 2020 to address the needs of developing countries. However, no specific guidelines currently exist on who should contribute, how much one should contribute, and the way the fund is to be spent.

In conclusion, it appears highly unlikely that a decisive international policy framework is going to be implemented to contain global warming. As such, top priority should be given to national and regional level adaptation measures. This, as Mr Schaffer pointed out, implies that there would be increased uncertainties for a range of sectors, including business and public policy.

Session 1: The Latest Climate Science

Chairperson:
Professor Kerry Sieh
Director
Earth Observatory of Singapore
Nanyang Technological University

Glacial Ice, Contemporary Climate Change, and the Future of Sea Level

Professor Kurt M. Cuffey
Professor and Chair
Department of Geography
Department of Earth and Planetary Sciences
University of California, Berkeley

Much uncertainty regarding climate change is attributed to the melting of terrestrial ice, of which there are two types – ice melt and iceberg essentially, as Professor Kurt Cuffey pointed out in his presentation. A host of factors, which he classified into global and local determinants, contributes to glacial ice-related sea level rise.

Global determinants include ice volume and thermal expansion, while local determinants include changes in the rotation and gravity of ice due to its weight. In addition, there is also a need to consider unavoidable uncertainties – which require flexible response measures – and a range of plausible glacial ice melting and sea level rise scenarios.

An anomaly observed in sea level rise beginning from the 1950s was articulated by Professor Cuffey. This anomaly was correlated with an observed phenomenon of the increasing retreat and thinning of mountain glaciers as driven by increases in global temperatures. Taking reference from existing estimates, Professor Cuffey gave projections for sea level rise by the year 2100. These figures take into consideration the melting of ice from Greenland, the Antarctica as well as mountain glaciers and ice caps. They also take into account thermal expansion.

In all, he postulated a 'Very Low' sea level rise scenario for the year 2100 at 13 centimetres (cm), a 'Low' scenario at 30 cm, 'High' scenario at 125 cm and 'Very High' scenario at 201 cm. Nonetheless, glacial ice melting remains a little known phenomenon that requires deeper study, in order to fully understand its implications.

Professor Cuffey also brought to attention the following considerations about future uncertainties. One of them concerns the socio-political-economic impact on carbon emissions, and the uncertainty for mitigation measures, such as introducing alternative energy sources.

Also, a range of 'hidden' factors, such as water vapour and stored carbon, might potentially increase the factor of uncertainty regarding global mean temperature rise. Consequentially, this could directly impact on thermal expansion and ice loss. Since uncertainty would not be overcome or significantly reduced anytime soon, Professor Cuffey argued, measures that could allay uncertainty have to be included as part of the plan to mitigate and adapt to climate change-induced sea level rise.

One of the first questions raised at the end of Professor Cuffey's presentation was with respect to the recent controversy surrounding the International Panel of Climate Change (IPCC) data on the rate of melting of the Himalayan Glaciers. Media reports in mid-January 2010 revealed that the source of the claim was not substantiated by peer-reviewed scientific evidence, but rather, by a media interview with a scientist conducted in 1999. To that, Professor Cuffey noted that there are large variations in the estimates depending on which scientific study was being referred to, based on particular periods.

He also acknowledged that this recent controversy also demonstrated that the IPCC itself does not exercise quality control in its research. In response to another associated question regarding the real estimates of the melting rate of the Himalayan Glaciers, Professor Cuffey suggested that, instead of focusing on how fast the glaciers would melt, a better measure would be to tackle the issue of sea level rise.

Another question was raised on whether there is a difference between temperatures taken on the Earth's surface and that taken from space via remote sensing. Professor Cuffey suggested that surface measurements are probably better as far as consistencies with glacial retreats and climate models are concerned.

One participant suggested the possibility of taking government action and adopting mitigation measures to deal with the ice melting scenarios proposed by Professor Cuffey. Another participant countered this by noting that mitigation measures, such as carbon sequestration, are still very costly.

One participant queried Professor Cuffey on what the accurate predictions about sea level rise were in relation to ice melting in the past two decades. To that, Professor Cuffey highlighted findings which showed that half the sea level rise had been attributed to thermal expansion while the other half had been due to ice loss, mostly from melting glaciers.

However, Professor Cuffey cautioned that the rate of ice loss over the past 20 years is still considered small compared to the potential projections. He pointed out that huge differences exist between the highest and lowest estimates of ice loss. In addition, the effect of temperatures varying from one region to another has to be taken into account.

Historical Perspectives on Climate-induced Food and Water Insecurities

Professor R. Lawrence Edwards
(In collaboration with Hai Cheng and Pingzong Zhang)
George and Orpha Gibson Chair of Earth Systems Science
and
Distinguished McKnight University Professor
University of Minnesota

Being aware of the historical antecedents illuminating the relationship between climate change and food/water insecurities could help in better understanding similar modern phenomena. Professor R. Lawrence Edwards highlighted the usefulness of dating cave calcite records in order to establish the link between climate and ancient cultures which might have potentially adapted to changes in rainfall and farming patterns. Such dating techniques, though crude, Professor Edwards pointed out, still represent a valuable means to allow a better understanding of the climate-cultural relationship.

According to analytical results gleaned from the dating of Chinese cave calcite, it was found that its oxygen isotopic composition was related to summer rainfall. Extensive Chinese records revealed a clear relationship between changes in climatic patterns and socio-economic-political changes in different Chinese dynasties. The low summer rainfalls recorded for the final years of the Tang, Yuan and Ming Dynasties were closely related to the socio-political upheavals during those periods.

Severe droughts resulted in peasant uprisings and helped facilitate the eventual demise of the three dynasties, according to anecdotal evidence. On the other hand, a high summer rainfall recorded at the beginning of the Northern Song Dynasty was closely related to national prosperity during that particular period. The Northern Song Strong Monsoon Period (NSSMP) in the period 960-1020 AD

allowed rice production to flourish and hence the tripling of the Northern Song population at that time.

Beyond ancient China, Professor Edwards also pointed to inter-regional climatic relationships which have direct ramifications on climatic patterns in other specific areas. For instance, there was a relationship between the East Asian Monsoon (which affected NSSMP and thus the flourishing of the Northern Song Dynasty in its early days) and the Indian Monsoon. It was thanks to this inter-monsoonal linkage that the ancient Guge Kingdom located in Western Tibet prospered.

Some other examples of inter-regional climatic relationships and their effects on socio-economic-political conditions, as highlighted by Professor Edwards, included the North Atlantic/West European climatic patterns linked to the rise and fall of the Vikings in Greenland. Another interesting study found a correlation between the socio-economic-political state of the Tang Dynasty and the Mayan Kingdom and inter-regional climatic interactions. While the wet seasons were linked to prosperity during those eras, dry seasons were correlated to their declines.

These research findings highlighted the interdependence among regions under climatic interactions across the globe. The ancient records in the case of China and parts of Europe and South America illuminated the direct relationship between climatic patterns and the socio-economic-political conditions at any period of time. Therefore, climatic conditions prevailing in one state could potentially have socio-economic-political spillover effects on other states, notwithstanding geographical distance. This certainly has significant implications in modern day climatic phenomena and interstate security relations.

During the discussion at the end of the presentation, there was a comment on how Professor Edward's study appears to parallel findings performed on the ancient Indonesian Mataram civilisation, during which there was migration from central to eastern Java. One participant asked why stalactites were not being used as dating samples. To that, Professor Edwards responded that stalactites are less ideal as test samples for the dating process, as compared to stalagmites, which are easier to examine.

Session 2: Impact on Food Security in Southeast Asia

Chairperson:
Associate Professor Mely Caballero-Anthony
Head
Centre for Non-Traditional Security Studies
S. Rajaratnam School of International Studies
Nanyang Technological University

Impacts of Climate Change on Food Security in Southeast Asia

Dr Mark W. Rosegrant
Director
Environment and Production Technology Division
International Food Policy Research Institute

A variety of factors, Dr Mark Rosegrant pointed out, could further drive rising food prices especially as the world population continues to increase. Climate change constitutes a multiplying force behind this phenomenon, since its effects directly impinge on the future prospects of agricultural growth and food security.

In recent times, an array of methodologies has been employed to study the impact of climate change on agricultural production. The International Model for Policy Analysis of Agriculture Commodities and Trade (IMPACT) 2009, that essentially models global food supply and demand with global hydrology up to the year 2050, serves as a good example of modern techniques used to study the effect of climate change on food security.

Using such modelling techniques, projections for future food supply and demand conditions with respect to climate change could be derived. For instance, using IMPACT 2009 modelling, it was found that by 2050, water scarcity would result in a decrease of 300 million metric tonnes of grain produced as compared to 100 million metric tonnes in 1995. Based on results gleaned from IMPACT 2009, it is found that climate change-induced percentage decrease in grain production in 2050 is greater when grains are placed in rain-fed conditions than when they are placed in irrigated conditions, assuming the absence of carbon fertilisation. This study was based on two primary types of grains – rice and wheat – in Asia.

Besides climate change-induced alterations in rainfall patterns, other climate change effects, such as sea level rise, also play crucial roles in affecting grain production. The potential loss of rice production areas using IMPACT modelling for Cambodia, Thailand and Vietnam, based on 1 metre (m) and 3 m sea level rise projections, is considerable. Take the case of Vietnam for instance: a 1 m rise in sea level could potentially lead to a 32 per cent loss in rice lands, and 52 per cent loss in a 3 m sea level rise scenario.

The loss of arable lands as a result of climate change-induced alterations in rainfall patterns and sea level rise, Dr Rosegrant highlighted, could lead to price volatility in vital grain crops and this would have a serious impact on food security. Consequently, food security woes could lead to other consequences such as health problems, especially the issue of child malnutrition in less developed regions. Another major problem which has to be contended with is the potential water scarcity issue. Using IMPACT 2009 modelling for the years 2000, 2025 and 2050, water requirements for irrigation alone are projected to far exceed those for livestock production as well as industrial and domestic uses.

To illuminate this problem, most contemporary modelling studies, as highlighted by Dr Rosegrant, showed that the supply reliability for irrigation water is generally projected to decline in the period 2000-2050. As a result, this would lead to losses in grain production. Another exacerbating factor to be considered is the issue of high energy prices. Higher energy costs would drive up grain production costs, such as that for water pumping, conveyance and desalination.

Moreover, Dr Rosegrant pointed out that climate change adaptation carries with it tangible costs on agricultural production too. Agricultural investments, in the form of research, irrigation expansion and enhancement of efficiency, as well as infrastructure construction, would lead to additional exorbitant costs. This would therefore raise the costs of grain production, impinging further on food security, especially for less developed and less endowed countries.

In conclusion, Dr Rosegrant argued that climate change would have a negative effect on agricultural production, through environmental phenomena and additional adaptation-related costs. However, agricultural adaptation to climate change constitutes a crucial and viable solution, notwithstanding the costs involved. Especially important, he pointed out, is the need to invest in agricultural research (crop breeding techniques), irrigation and rural infrastructure, just to name a few. Economic incentives to maximise efficient water usage are also vital, as a way to alleviate the projected increase in water scarcity.

There is certainly a need to continue supporting research on the interactions between climate change and agriculture in order to facilitate proper resource allocations for building national and international resilience capacities. Nonetheless, Dr Rosegrant opined, a more ideal long-term solution would be to mitigate climate change through rendering support for the development of carbon markets and striving for better progress in international consensus-building on mitigation measures.

Impacts of Climate Change on Fisheries and Aquaculture in Southeast Asia

Dr Patrick Dugan
(In collaboration with Marie-Caroline Badjeck, Edward Allison and Suan-Pheng Kam)
Deputy Director General and Research Director
WorldFish Center, Penang

The marine ecosystem constitutes one of the most important sources of human livelihoods. Approximately 8 per cent of the world's population depends on fisheries for its economic well-being. Perhaps more importantly, Dr Patrick Dugan highlighted, fisheries provide a vital source of animal protein for 2.9 billion people worldwide. However, the aquaculture industry is experiencing rapid growth due to a steady decline of capture fish stocks; the decline being linked to human-induced factors such as overfishing.

The aquaculture sector, while still in its nascence, is dynamic due to its responsiveness to market developments. In most Asian countries, Dr Dugan highlighted, aquaculture has literally overtaken capture fisheries in terms of production volume and value. This trend is set to continue, especially when declining capture fish stock levels mean that aquaculture is being increasingly seen as a solution to domestic food security problems.

Besides human-induced factors, one of the key driving factors for the contemporary 'fisheries challenge' is climate change. This phenomenon impacts the marine ecosystem in several ways – through ocean acidification for example. The consequences of climate change-induced effects on fisheries could be wide-ranging, but first and foremost, it would have an impact on the livelihoods of fishing communities that rely heavily on capture fish stocks for economic and subsistence purposes.

One study published in 2009, based on a 'business as usual' scenario set for the year 2055, predicted a gain catch potential in the high-latitude regions and a loss catch potential in tropical regions. The extent of exposure to climate change and socio-economic sensitivity to climate change-induced fishery impacts determine regional vulnerabilities. Adaptive capacity plays an important role in 'softening' the impact and alleviates vulnerabilities.

Unfortunately, countries which are economically and nutritionally the most vulnerable to climate change-induced fishery impacts belong to the least developed regions, particularly Southeast Asia. In this region, capture fisheries and aquacultures are exposed to climate change-induced environmental effects, such as rising sea levels and weather hazards.

The lower Mekong Delta region, upon which the resident population is dependent for their livelihoods, serves as a prime example of a particularly vulnerable zone that is exposed to climate change-induced fishery impact. Climate change might potentially add to existing problems, such as weak governance and competing demands for land and water. In all, climate change creates multiplier effects on existing coastal and inland fishery problems.

Dr Dugan also argued that other factors could exacerbate the present and future situation. An increased demand

for food and a concomitant reduction in capture fishery levels would lead to an increased demand for aquaculture. However, climate change-induced environmental strains, such as rising sea levels, would threaten the future of aquaculture. To mitigate these strains, a range of measures could be proposed.

One way, he suggested, would be to develop new fishery and aquaculture technologies to produce new fish species to be bred in response to hydrological variations. Due to increasing recognition of the role played by climate change in the future of fishery and aquaculture, a range of research agendas might be worth considering, by looking at how fisheries and aquaculture could adopt climate change adaptation and mitigation measures.

For a start, Dr Dugan proposed, a development agenda could be devised to promote the fishery and aquaculture sectors' adaptation to climate change. Under this framework, adaptation funds could be allocated to vulnerable coastal and inland fishers and farmers. In addition, investments could be considered for development funding to sustain and increase benefits for fisheries and aquaculture with the aim of establishing food security, poverty reduction and economic growth.

Adapting Agriculture to Climate Change – GMO, Practices and Technologies

Dr Reiner Wassmann
Coordinator
Rice and Climate Change Consortium
International Rice Research Institute

Climate change has a multifaceted impact on agricultural yield. Increase in global temperatures, changes in rainfall patterns, as well as weather hazards are consequences of climate change. These effects lead to a significant impact on the production of key grain crops, taking rice as a key example. According to Dr Reiner Wassmann, the multifaceted impact on rice production yield could have implications on food security. This is especially so for the East, where rice constitutes a key staple in regional diets.

The global mean surface temperature increased by about 0.5 degree Celsius in the 20th Century as a result of global warming and is projected to increase by 1.4 to 5.8 degree Celsius in this present century. This could adversely affect the healthy growth of rice crops and hence reduce overall production yield.

Extremely high temperatures during vegetative growth reduce tiller number and plant height, and negatively affect panicle and pollen development, leading to a decrease in rice yield potential. However, high temperatures are particularly important at the flowering stage (this typically occurs in the mid-morning). But continuous exposure to high temperatures (more than 35 degree Celsius) for a few hours can greatly increase spikelet sterility through reduction of pollen viability, eventually causing irreversible yield losses.

Other climate change-induced environmental factors significantly affect rice production yields. For example, currently about 40 per cent of the total rice agricultural lands are classified as rain-fed (lowland or upland) while approximately 3.5 million hectares of rice lands are still being classified as deepwater or flood-prone. As such, changes in rainfall patterns constitute a highly important factor in determining the yield of rain-fed rice species in particular.

Sea level rise, accelerated by climate change, could also seriously affect low-lying coastal rice lands found typically in the Mekong, Irrawaddy and the Ganges-Brahmaputra river deltas. Rice crops are vulnerable to coastal inundation as a result of sea level rise. Lastly, weather hazards induced by climate change could impose additional risks to rice production. Tropical cyclones, which might become more intense as a result of climate change, would be characterised by higher peak wind speeds and heavier precipitation – all of which could affect proper rice growth.

In order to sustain rice yield and quality in the context of climate change, Dr Wassmann argued, there is a need to embrace new tools and identify genetic strategies to overcome the climatic effects induced by climate change on grain growth, such as the development of selection

tools that could enable rice breeders to continue to select high yield and quality grain in a warmer world.

In fact, the advent of GMO technologies has led to a rapid increase in areas allocated for such types of grain crops worldwide. GMO technologies have been proven successful and carry with them considerable prospects for the future. Successful examples to illustrate the viability of GMO measures with respect to rice crops include pest- and herbicide-resistant rice species. R&D is still being carried out with the hope of uncovering new GMO rice types.

GMO technologies could be utilised to take advantage of climate change effects. For instance, the high concentration of atmospheric carbon dioxide due to global warming could be harnessed to increase rice yield productivity. Such species of GMO rice types, known as 'C4 rice', would require less water, thus using water more efficiently. Dr Wassmann highlighted ongoing research at the International Rice Research Institute which strives to produce and test rice prototypes that could convert the maximum fraction of solar energy into the maximum amount of grain-stored chemical energy, using the smallest amounts of land, water and fertiliser in the shortest time possible. If successful, this particular GMO rice species could mitigate the risks imposed by sea level rise.

Further, GMO rice crops could be made resilient in the face of a reduction in water supply and, in the face of sea level rise, require less land due to the loss of fertile farming ground as a result of coastal inundation. In the face of weather hazards, GMO technologies could make rice crops more tolerant against climatic stresses.

In summary, Dr Wassmann argued, prospects for the expansion of GMO practices appear assured as rice crop production experiences an additional strain in the form of climate change, aside from rapid population growth and the associated rising demands for food. Climate change would lead to rice crops undergoing more detrimental effects stemming from droughts due to changes in rainfall patterns, increased possibility of submergence and increased salinity due to rising sea levels, as well as an increased incidence of weather hazards. GMO technologies for sustaining rice crop yields could serve as a viable solution to this range of climate change problems.

Private Sector Perspective on Agriculture in Southeast Asia

Mr Richard Haire
Managing Director and Regional Head – Australia & New Zealand
OLAM

The 'knowns' of climate change, such as the cause of this phenomenon, are generally known to the world. However, Mr Richard Haire argued, the 'big unknowns' of climate change have yet to be fully understood. Such uncertainties lie in the relative significance of human activity on climate change, characteristics of this phenomenal cycle, regional impacts on agricultural production and the policy responses that would be devised in the region to counter climate change impact.

According to the Agriculture Outlook 2009-2018 published jointly by the Organisation for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization (FAO), food demand as a result of world population growth is projected to increase in the years to come. This is especially going to be so for less developed regions, which could see an annual 2 per cent increase in population. As such, the allocation of more land for food production would become increasingly costly. What this problem translates to is the need for greater productivity in the face of adversity.

Measures could be conceived to increase crop yield (or 'more crop per drop' in the words of Mr Haire), reduce carbon footprints in the process of food production, as well as explore methods to produce more from less resources. However, investment alone, Mr Haire pointed out, is barely sufficient in ensuring food security. He suggested that, in the face of climate change impacts on future food production, R&D as well as the reforming of institutions and infrastructures are necessary.

Due to strains on food security imposed by population growth and climate change, the politics of food security would intensify, along with a higher incidence of supply disruptions and price volatility. This leads to higher food production costs that require sovereign investments in R&D and production systems. The need to impose costs

on carbon emissions would also increase risk profiles and capital costs.

The private sector could play a part in mitigating the impact of climate change on food security. At the corporate level, some potential strategic responses could be implemented to counter these contingencies. One way corporate entities could help to alleviate the impact of climate change and food insecurity would be to implement risk management and opportunity management strategies (through market-based mechanisms). Product integrity systems (virtual supply chains) could also be feasible. In addition, logistics management could be conferred greater emphasis as a core skill set.

A notable idea worth considering, Mr Haire suggested, is the establishment of more agricultural corporations which could boost food production while reducing the carbon footprint via 'green funds' (i.e. funds which are used only for 'green' investments).

Mr Haire concluded his presentation by posing a set of questions to the audience. One interesting question was whether there might be a role for a global oversight of resource allocation in a resource-constrained world. Another notable question invited participants to consider whether global food is a form of private or public good.

Discussion

A flurry of discussions ensued at the end of the first day's presentations. In general, participants raised the issue about the need to realistically prepare for short- and medium-term contingencies of climate change. In particular, it was noted that the lack of and contestability of existing long-range scientific projections of climate change effects on pertinent issues, such as sea level rise and food security, might not be regarded as realistic enough to serve policymaking purposes, which are usually more tailored to address concerns in the immediate term.

Some participants suggested that, rather than looking at capacity-building simply as a form of climate change adaptation, it might be better to conceive it as a key development policy instead. With that, policy prescriptions should be tailored towards addressing the most pertinent problems related to food security and poverty reduction, just to name a few. To be sure, while these measures are carried out as a key development strategy, the recognition that climate change is one of the key determining factors of future human well-being could add impetus to the development process. With that in mind, capacity-building would be implemented on the basis of development rather than tied to geopolitical baggage; the latter was illustrated by the outcomes of the Copenhagen Summit in December 2009.

One participant argued that climate change adaptation and mitigation remain merely concepts at this point of time, while the implementation of adaptation and mitigation measures requires more than just concepts. The requisite tools needed for the implementation of these measures have to be devised. Part of this endeavour might require innovative approaches which are yet to be tested. In addition, scientists and policymakers have to continually revisit existing information on climate change and its effects, and thus seek ways to better exploit existing and new data to implement climate change mitigation and adaptation measures.

There was also intense discussion on the 'disconnect' between the provision of scientific knowledge and actual policymaking. One participant opined that policymakers might not act in the way climate scientists would expect them to. More often than not, the participant contended, policymakers interpret the scientific information they are provided with in a different manner than is hoped by climate scientists.

Another participant observed that the day's discussion was largely dominated by issues related to the role of science, business and government, with too little mention of the role of non-state actors, such as civil society organisations, in the area of promoting climate change adaptation and mitigation. The participant suggested that this is one area that deserves greater attention especially since it is not sufficient for scientists as well as public and private sectors alone to cope with the effects of climate change.

Session 3: Human Migration in Southeast Asia

Chairperson:
Mr Aaron Shahril Yusoff Maniam
Deputy Director and Head
Centre for Strategic Studies
Strategic Policy Office
Prime Minister's Office, Singapore

Migration in ASEAN

Mr Federico Soda, Sr
Regional Programme Development Officer
International Organization for Migration

The second day of the conference began with a presentation on migration and ASEAN. According to Mr Federico Soda, the world's migrant population stands at approximately 214 million in total, of which ASEAN itself occupies 9 per cent. Intra-regional as opposed to inter-regional migration is a predominant feature in ASEAN. Several pull and push factors drive this trend, including intra-regional economic disparities, which are magnified by globalisation.

Labour migration constitutes a predominant feature within intra-ASEAN migration patterns, and it is largely driven by socio-economic disparities. This form of migration is particularly important since labour remittances from host countries contribute significantly to the economies of sending states, such as the Philippines and Thailand. However, due to poor regulatory frameworks on migration in the region, transnational security risks such as human trafficking exist.

Forced migration, unlike voluntary types such as labour migration, had historically occurred in ASEAN, dating from examples such as the Indochina wars back in the 1950s-80s, when massive refugee flows to Indonesia, Malaysia and Thailand were observed. In contrast, environmental migration is comparatively difficult to analyse because environmental 'push' factors do not constitute the primary cause for intra-regional migration.

Internal migration is extensive in Indochina, particularly in Cambodia, Myanmar, Thailand and Vietnam. This form of migration is rural-rural and rural-urban in nature, driven largely by economic and environmental pressures. The latter aspect deserves closer attention, Mr Soda pointed out. To this day, the concept of 'environmental migrants' remains new and according to the International Organization for Migration, refers to 'persons or groups of persons who, for compelling reasons or sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad'.

To environmental migrants, migration is an adaptation measure. However, it remains a difficult challenge to establish a direct relationship between migration and climate change, since a multitude of other factors exist. No definite information on environmental migration is yet available. While one estimate puts the figure of environmental migrants at 200 million by 2050, the IPCC projected the presence of 25 million to 1 billion environmental migrants by the same year. Rising sea levels, resource competition and increased climatic anomalies as a result of climate change could have potential consequences on environmental migration nonetheless.

ASEAN faces the possibility of significant environmental migration, be it due to long-term climate change effects or natural disasters on the region's large coastal and rural/agricultural populations vulnerable to sea level rise and climatic anomalies. However, due to intra-regional political and economic disparities, not all ASEAN countries are adequately prepared to handle environmental migration. Lack of research capacities, data and methodological difficulties, Mr Soda added, hinder regional preparations for this contingency.

Mr Soda proposed the following policy measures for ASEAN in managing intra-regional migration, including increased intra-regional cooperation, state-to-state assistance, better economic development policies as well

as planned resettlement schemes (as a final resort). There is also need to bolster regional research capacities in order to better understand migration patterns in ASEAN, with special regard to the effects of climate change.

Demographic and Economic Implications of Climate Change Impacts and Human Migration in Southeast Asia

Professor Graeme Hugo
ARC Professorial Research Fellow and Professor of Geography
The University of Adelaide

Echoing Mr Soda's view that projections of environmental migration lack credibility and is hence difficult to analyse, Professor Graeme Hugo argued that this is due to the limitations of present climate science in identifying the location and severity of impacts as well as the lack of comprehensive mobility data. He further pointed out the complex inter-relationship among migration, environment, resources and development, thus reinforcing the view that there are rarely single causes of migration.

Environmental migration, according to Professor Hugo, is predominantly internal migration yet the world's focus is more often on international migration. Not much is known about environmental migration despite the nascent, emerging debate on the causes of this phenomenon. Southeast Asia especially is susceptible to environmental hazards which could drive internal migrations. Key 'hotspots' of climate change impact in Southeast Asia include low-lying coastal areas in which major mega cities of the region are concentrated, densely-populated delta regions, low-lying islands as well as zones of enhanced hurricane activity.

In densely-populated climate change 'hotspots', the level of vulnerability is correspondingly high. Responses to climate change, other than mitigation and adaptation measures, include migration. However, Professor Hugo pointed to the need to consider climate change-induced migration in the context of, and not separately from, broader migration patterns. While environmental anomalies could add pressure to relocate, these are hardly the only driving forces. Professor Hugo argued that economic disparities could also affect tendencies of migration. For instance, he pointed out, the poor would usually be the most environmentally-affected communities yet they might not possess the means to relocate. This aspect presents a policy challenge in the field of analysing environmental migration.

While it is difficult to accurately project the degree of environmental migration in 'hotspot areas' due to many existing uncertainties, it is still plausible to identify the population 'at risk' from sea level rise, for instance. This aspect is particularly important since it could facilitate targeted intervention measures and the creation of suitable adaptation institutions and mechanisms. With respect to Southeast Asia, it is generally easy to identify populations at risk. Such vulnerability measurements take into account demographical and economic considerations.

Poverty constitutes the central issue of population vulnerability to climate change and environmental migration patterns. The poor, who are especially dependent on natural resources for their livelihoods, are typically less well endowed and also lack awareness and information on environmental hazards. As such, these segments of the population often lack even community-level economic resources to support environmental adaptation, not to mention the resources to flee their hazard-prone areas. Moreover, they have the least access to formal institutional assistance and therefore, their precarious situation could often go unnoticed until it is too late.

Nonetheless, Professor Hugo argued that migration would still constitute an important form of adaptation among environmentally-affected communities in the region. Environmentally-induced population displacement patterns could incur massive additional economic, social, political and environmental costs unless they are carefully planned for. Such deliberate planning involves national and sub-national efforts, though it is important not to forget the international dimensions where funding especially comes into play.

Policy measures suggested by Professor Hugo include an emphasis on the poorer segments of the population vulnerable to climate change. With respect to Southeast Asia, he pointed out the need to improve governance, given the region's weakness in this area, so as to reinforce the proper implementation of adaptation and migration management policies. Contingency planning for large-scale resettlements, mostly within countries, would have to be catered for even if this constitutes a last-ditch measure. Other measures include raising public awareness, especially among the rural communities, about climate change. The lack of existing international and regional cooperation on migration means that this aspect needs to be improved as well.

One participant asked Professor Hugo how he could factor in the duration of migration, since the issue of mobility has not been 'really reflected' in statistics. To that, Professor Hugo acknowledged that existing data examines mostly permanent migration, but contended that most human migrations have been temporary, especially in the event of natural disasters. He also opined that migration policies that encompass a range of options are required, so as to allow for a differentiation between permanent and non-permanent migration. Professor Hugo cautioned against becoming 'slaves to data', which creates tendencies to misinterpret statistical findings.

Professor Hugo pointed out that some migrants, dislocated by natural disasters, might not necessarily stay permanently in the host region, citing the example of Cyclone Nargis back in 2007. In the aftermath of the cyclone, he highlighted, most of the affected populace were more concerned about returning to their homelands to cultivate rice crops due to their worries about food security and livelihoods.

In the case of Aceh after the Indian Ocean Tsunami in December 2004, there was also a mix of migrants who remained in the disaster zone and those who, once dislocated, had not returned. The latter accounted for approximately a third of all migrants. This depends to a large extent on whether the particular affected community has existing relations with other areas to which it is dislocated to. Massive-scale reconstruction efforts in Aceh, amounting to about US$7 billion in all, might also have mitigated the driving force for mass migration after the tsunami.

Looking at the most recent case of the Haitian earthquake, the amount of funding available could seriously influence the scale of migration. Professor Hugo suggested that the successful case of garnering sustainable international funding for reconstruction in Aceh could serve as an apt example for Haiti to follow.

One participant expressed the view that environmental migration lacks proper definition, thus affecting precise measurements of the costs of such movements. This is also impeded by the lack of data. Moreover, climate change is not the only driver of migration, hence it might not be appropriate to categorise migrants into a distinct group known as 'environmental migrants'. The participant wondered whether resources should be allocated to address poverty in general, due to its current salience, rather than climate change, whose future consequences are still clouded with uncertainty. In response, Professor Hugo opined that implementing adaptive measures and promoting climate change resilience are not separate issues. He felt that priorities have to be established and efforts have to be accelerated in the most vulnerable regions.

There was also a debate on whether trans-boundary environmental degradation is caused by migrants. To that, both Professor Hugo and Mr Soda opined that there has been a tendency in the mass media to scapegoat migrants as the creator of trans-boundary environmental degradation. However, they also acknowledged that migration could affect the health and well-being not only of the host community but the migrant community as well. This problem is usually poorly handled by government authorities, leading to a lack of access for migrant communities to adequate social services and housing.

Programme

Day One: 26 January 2010

08:30 – 09:00 **Registration**

09:00 – 09:15 **Setting the Scene:**

Welcome Remarks
Professor Kerry Sieh
Director
Earth Observatory Singapore
Nanyang Technological University,
Singapore

Starving Tigers? COP15 Outcomes
Mr Andreas Schaffer
Senior Principal, Monitor Group

09:15 – 12:00 **Session 1: The Latest Climate Science**

Chairperson:
Professor Kerry Sieh
Director
Earth Observatory Singapore
Nanyang Technological University,
Singapore

09:15 – 10:00 **Glacial Ice, Contemporary Climate Change, and the Future of Sea Level**
Professor Kurt M. Cuffey
Professor and Chair,
Department of Geography,
Department of Earth and
Planetary Sciences
University of California, Berkeley

10:00 – 10:30 **Sea Level Rise: Q&A**

10:30 – 10:45 **Coffee Break**

10:45 – 11:30 **Historical Perspectives on Climate-induced Food and Water Insecurities**
Professor R. Lawrence Edwards
(In collaboration with Hai Cheng and Pingzong Zhang)
George and Orpha Gibson Chair of
Earth Systems Science and
Distinguished McKnight
University Professor
University of Minnesota

11:30 – 12:00 **Historical Perspectives: Q&A**

12:00 – 12:15 **Wrap-up Group Discussion**

12:15 – 13:15 **Lunch**

13:15 – 16:10 **Session 2: Impact on Food Security in Southeast Asia**

Chairperson:
Associate Professor
Mely Caballero-Anthony
Head
Centre for Non-Traditional
Security Studies
S. Rajaratnam School of
International Studies,
Nanyang Technological University,
Singapore

13:15 – 13:50 **Impacts of Climate Change on Food Security in Southeast Asia**
Dr Mark W. Rosegrant
Director, Environment and Production
Technology Division
International Food Policy
Research Institute

13:50 – 14:10 **Impacts of Climate Change on Fisheries and Aquaculture in Southeast Asia**
Dr Patrick Dugan
(In collaboration with Marie-Caroline Badjeck, Edward Allison and Suan-Pheng Kam)
Deputy Director General and Research Director
WorldFish Center, Penang

14:10 – 14:40 **Impact on Food Security: Q&A – Part 1**

14:40 – 15:00 **Coffee Break**

15:00 – 15:20 **Adapting Agriculture to Climate Change – GMO, Practices and Technologies**
Dr Reiner Wassmann
Coordinator,
Rice and Climate Change Consortium
International Rice Research Institute

15:20 – 15:40 **Private Sector Perspective on Agriculture in Southeast Asia**
Mr Richard Haire
Managing Director and Regional Head – Australia & New Zealand
OLAM

15:40 – 16:10 **Impact on Food Security: Q&A – Part 2**

16:10 – 16:50 **Group Discussion**

16:50 – 17:00 **Wrap Up Day 1**
Professor Kerry Sieh
Director
Earth Observatory Singapore
Nanyang Technological University, Singapore

Day Two: 27 January 2010

09:00 – 10:30 **Session 3: Human Migration in Southeast Asia**

Chairperson:
Mr Aaron Shahril Yusoff Maniam
Deputy Director and Head
Centre for Strategic Studies
Strategic Policy Office, Prime Minister's Office, Singapore

09:00 – 09:20 **Migration in ASEAN**
Mr Federico Soda, Sr
Regional Programme Development Officer
International Organization for Migration

09:20 – 09:40 **Demographic and Economic Implications of Climate Change Impacts and Human Migration in Southeast Asia**
Professor Graeme Hugo
ARC Professorial Research Fellow and Professor of Geography
The University of Adelaide

09:40 – 10:30 **Human Migration in Southeast Asia: Q&A**

10:30 – 11:00 **Coffee Break**

11:00 – 11:45 **Overview of Scenario Exercise, Scenario Examples and Breakout Group Preparations**

Mr Andreas Schaffer
Senior Principal, Monitor Group
and
Mr Aaron Shahril Yusoff Maniam
Deputy Director and Head
Centre for Strategic Studies
Strategic Policy Office,
Prime Minister's Office, Singapore

11:45 – 12:00 **Breakout Group Finalisation**

12:00 – 13:00 **Lunch**

13:00 – 09:20 **Starving Tigers? Southeast Asian Climate Change Scenarios for the 21st Century and Implications for Singapore**

Chairperson:
Mr Andreas Schaffer
Senior Principal, Monitor Group

13:00 – 14:30 **Breakout Groups**

14:30 – 15:30 **Group Read-out**

15:30 – 16:30 **Discussion and Synthesising Scenarios**

16:30 – 17:15 **Implications for Singapore**

17:15 – 17:45 **Next Steps: Where Do We Go from Here?**
Mr Andreas Schaffer
Senior Principal, Monitor Group

17:45 – 18:00 **Closing Remarks**
Professor Kerry Sieh
Director
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End of Conference

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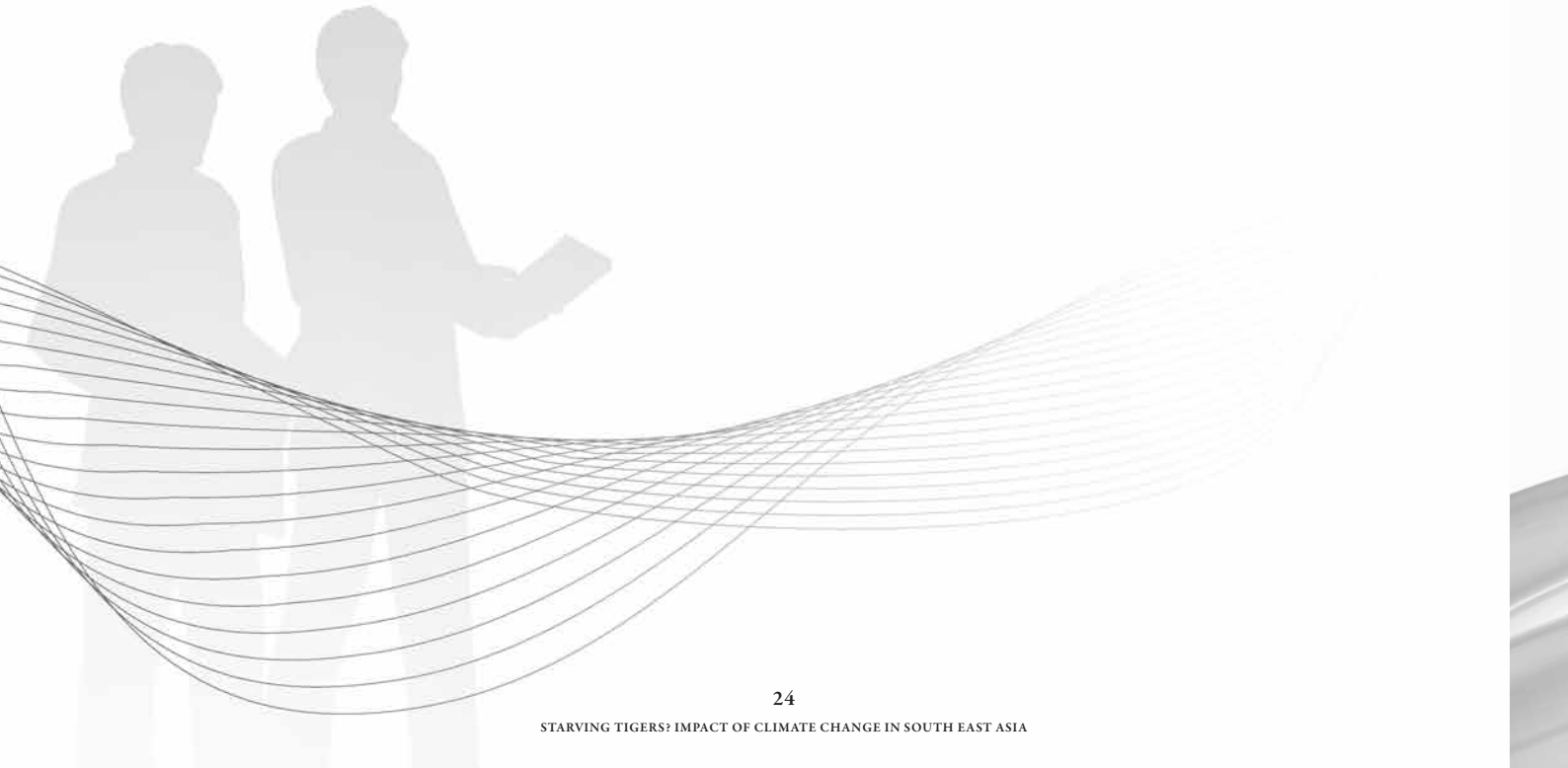

About the Earth Observatory of Singapore

EOS Mission

To conduct fundamental research on earthquakes, volcanic eruptions, tsunamis and climate change in and around Southeast Asia, toward safer and more sustainable societies.

Research at the Earth Observatory of Singapore (EOS) is focused on understanding Southeast Asia's dynamic tectonic plates, oceans and atmosphere. By characterizing the tectonic, volcanic and climatic processes responsible for these hazards, EOS aims to promote better forecasts of natural processes. These will aid governments, communities and businesses to anticipate and adapt creatively to environmental challenges, as well as develop and implement visionary policies.

EOS is funded by Singapore's National Research Foundation (NRF), the Ministry of Education (MoE) and Nanyang Technological University.

Tectonics

One of EOS' broad goals in tectonic studies is to understand the earthquake geology of Southeast Asia for reliable long- and medium-term forecasts of earthquakes and tsunamis. This goal would be reached via integrated geologic, geodetic, and seismologic observations and interpretations, performed in collaboration with scientists in neighbouring countries.vwith the School. A small and select Ph.D. programme caters to students whose interests match those of specific faculty members.

Volcanoes

The volcanology group studies selected volcanoes of Southeast Asia with emphasis on both observation and modeling. Practical outcomes of our research will be tools and data for useful long- and short-term forecasts of eruptions, assessments of their environmental and societal impact, and promotion of mitigation.

Climate Change

Climate research at EOS currently concentrates on understanding regional Southeast Asian climate and its global significance. By better understanding the complex interactions between human activities and flooding, atmospheric temperatures and other climatic parameters, we can develop the tools, attitudes and technologies necessary for our survival.

About the Centre for Non-Traditional Security (NTS) Studies

The **RSIS Centre for Non-Traditional Security (NTS) Studies** in the **S. Rajaratnam School of International Studies (RSIS),** conducts research and produces policy-relevant analyses aimed at furthering awareness and building capacity to address NTS issues and challenges in the Asia-Pacific region and beyond.

To fulfil this mission, the Centre aims to:

- Advance the understanding of NTS issues and challenges in the Asia-Pacific by highlighting gaps in knowledge and policy, and identifying best practices among state and non-state actors in responding to these challenges
- Provide a platform for scholars and policymakers within and outside Asia to discuss and analyse NTS issues in the region
- Network with institutions and organisations worldwide to exchange information, insights and experiences in the area of NTS
- Engage policymakers on the importance of NTS in guiding political responses to NTS emergencies and develop strategies to mitigate the risks to state and human security
- Contribute to building the institutional capacity of governments, and regional and international organisations to respond to NTS challenges

Our Research

The key programmes at the **RSIS Centre for NTS Studies** include:

1) Internal and Cross-Border Conflict Programme
   - Dynamics of Internal Conflicts
   - Multi-level and Multilateral Approaches to Internal Conflict
   - Responsibility to Protect (RtoP) in Asia
   - Peacebuilding

2) Climate Change, Environmental Security and Natural Disasters Programme
   - Mitigation and Adaptation Policy Studies
   - The Politics and Diplomacy of Climate Change

3) Energy and Human Security Programme
   - Security and Safety of Energy Infrastructure
   - Stability of Energy Markets
   - Energy Sustainability
   - Nuclear Energy and Security

4) Health and Human Security Programme
   - Health and Human Security
   - Global Health Governance
   - Pandemic Preparedness and Global Response Networks

The first three programmes received a boost from the John D. and Catherine T. MacArthur Foundation when the RSIS Centre for NTS Studies was selected as one of three core institutions leading the MacArthur Asia Security Initiative* in 2009.

Our Output

Policy Relevant Publications

The **RSIS Centre for NTS Studies** produces a range of output such as research reports, books, monographs, policy briefs and conference proceedings.

Training

Based in RSIS, which has an excellent record of post-graduate teaching, an international faculty, and an extensive network of policy institutes worldwide, the Centre is well-placed to develop robust research capabilities, conduct training courses and facilitate advanced education on NTS. These are aimed at, but not limited to, academics, analysts, policymakers and non-governmental organisations (NGOs).

Networking and Outreach

The Centre serves as a networking hub for researchers, policy analysts, policymakers, NGOs and media from across Asia and farther afield interested in NTS issues and challenges.

The **RSIS Centre for NTS Studies** is also the Secretariat of the Consortium of Non-Traditional Security Studies in Asia (NTS-Asia), which brings together 20 research institutes and think tanks from across Asia, and strives to develop the process of networking, consolidate existing research on NTS-related issues, and mainstream NTS studies in Asia.

More information on our Centre is available at www.rsis.edu.sg/nts

** The Asia Security Initiative was launched by the John D. and Catherine T. MacArthur Foundation in January 2009, through which approximately US$68 million in grants will be made to policy research institutions over seven years to help raise the effectiveness of international cooperation in preventing conflict and promoting peace and security in Asia.*

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