Forest health threats from globalisation and climate change

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Ladies and Gentlemen,

It is quite an honour to be asked to give this presentation at this important event. While I am not the world's expert on globalisation and climate change and its impact on forest health, I am in the fortunate position of being located in FAO Rome, at the hub of global information exchange. I am thus able to tap into the vast global expertise from countries as far ranging as DPR Korea to Libya – which will be mentioned in this presentation. We mainly hear about the negative side of globalisation and in fact my presentation will include some of the downside- but let me at least start with a positive aspect. A decade ago this presentation would not have been possible. As a result of globalisation of information, resources not previously available are now at our fingertips. I have thus borrowed freely from the work of a great many people, too numerous to mention here. I would however like to take the opportunity of acknowledging the direct contributions of the persons and organizations indicated here.

Slide 2 Contributors

Slide 3 Threats to forests and forest products
The list of potential threats to forest and forest products is very long-it includes but is not restricted to these. For the purposes of this presentation I will mainly be discussing the impacts of globalisation and climate change on insect and diseases (both endemic and introduced) and the interrelationships between host and environment.
Time does not permit detailed inclusion of woody invasive species and fire. This does not detract from their importance- in fact there is increasing concern about the impact of woody invasive species on forest health and vitality – especially in small island developing States where they may threaten the habitat of endemic species.

Slide 4 Forest threats
In the last decade there have been some major extreme weather events which have had adverse effects on the world's forests including the Indian Ocean Tsunami in 2004, storms and blizzards in Sweden in 2005, the Netherlands in 2007, China in 2008, France in 2009 and earthquakes in China in 2008 and in Haiti in early 2010.

Slide 5 Diebacks
The threat to the forests may not always be clear cut. For example diebacks may be caused by an interrelationship between some or all of the biotic and biotic threats mentioned previously. In 2007 the Russian Federation reported dieback of nearly a million hectares of boreal coniferous forests.

Slide 6 Threats to forests
Preliminary Global Forest Resource Assessment (FRA 2010) data shows that the extent of forest adversely affected by insects alone was 35 million hectares per year, noting that many countries did not report or under-reported in the temperate and boreal zone.

Outbreak that made the headline news: since the late 1990s the mountain pine beetle has devastated more than 11 million ha. of forests in Canada and the western United States spreading outside its historical range. This unprecedented outbreak has been exacerbated by dryer summers and warmer winters. The current outbreak in BC Canada is the largest ever recorded with a peak of 9.2 million ha. affected in 2006.

What does this cost? Insect pests, diseases and invasive plants cause substantial environmental and socio-economic losses, but existing estimates are difficult to confirm.

Slide 7 Impact
Outbreaks of forest pests combined with the threat of invasive species can reduce tree survival, yield and quality of forest products. They can threaten wildlife habitat, species biodiversity, and cultural values of forests.

Slide 8 Impact
Health problems may also disrupt natural fire cycles and deplete water. They may affect international trade in forest products owing to the risk of spreading pathogens, insects and invasive plants into new forest ecosystems. And most importantly, they may have negative impacts on livelihoods- case in point the mountain pine beetle in Canada where the loss of an estimated one billion trees is having direct impact on industry, and livelihoods are threatened.

Slide 9 Europe – Trends
Putting Europe in the global perspective: of the 50 countries including Russia, that the Global Forest Resources Assessment includes in the region Europe; 37 county reports/desk studies provided information representing 96% of the total forest area. Nota bene: the graphical representation of trends for those countries who have reported for all time periods, represents Europe minus Russia -when Russia is included the figures increase substantially. I am sure you are all aware that there were major storms in Europe in 1990, 1999/2000; 2004/05; 2007 and 2009 and a severe drought in 2003. Interesting correlations have been reported by countries on insect outbreaks and severe weather events. For example, during the last decade, 14 EU countries reported outbreaks of *Ips typographus* (European spruce bark beetle) and noted that severity of outbreak could be related to storm or drought conditions. The FRA study included both endemic and invasive pest species. Now I am going to focus on invasive species.

Slide 10 Invasive species
There are many and varied definitions for invasive species and alien invasive species but for the purposes of this presentation I will use this definition.

Slide 11 General traits of successful invasive species
To be successful an invasive species should exhibit most but preferably all of the criteria shown here.

Slide 12 Invasive species in forests Three levels
In forests invasive species may have impact at the three levels shown here.

Slide 13 How global change affects pests
Increasing international trade and climate change are cofactors increasing the international movement and establishment of forest pests. I will discuss these topics in depth.

In addition, changing land-use patterns including deforestation, habitat fragmentation and desertification all influence pest dynamics, but again time precludes any lengthy discourse. I should perhaps just mention the obvious; that disturbed ecosystems are easier to invade.

Slide 14 Causes of international pest movement
First I will discuss international trade and the factors that influence pest distribution. International movement of goods and people is increasing exponentially. Globalisation involves interactions of new trade partners throughout the world and faster travel over greater distances, which all contributes to pest movement.

Slide 15 Increasing global trade
Trade routes show increased international commerce due to globalization and the industrialization of developing countries. In the US alone imports of agricultural, fish, and forestry products are now more than $100 billion a year. Wood product imports increased 45 percent between 2002 and 2006, and exports increased 27 percent during the same period (USDA Foreign Agricultural Service, 2007). Such globalization carries with it the burden of increased opportunities for invasive species introduction.

Slide 17 Reinvasion - Dutch elm disease
Dutch elm disease is an interesting case of both reinvasion and evolution of invasive species. It is caused by a fungus which is vectored by bark beetles. The fungus was introduced into North America from Europe in the 1920s. It mutated in North America into a far more aggressive strain which was then reintroduced into Europe several years later.

Slide 18 Important pathways
Several major pathways have been identified for the introduction of invasive species
As well as the more conventional pathways of wood as a commodity there is growing concern about the increased interest in new trade, especially in plants: the desire for the new, the exotic, and of most concern, the semi-mature "instant" garden plant or tree. These larger pathways are harder to inspect and easier for pests to hide in.
Wood packing material, such as pallets, boxes, and crates, is a pathway for invasive species such as the Asian longhorned beetle and wood-inhabiting fungi.
Wood-boring beetles have also been detected in artificial plants, furniture, and other non treated wood products. Plants for planting can be pests themselves, or they may provide a pathway for invasive fungi, insects, and nematodes.
Escapes and releases from the exotic pet trade and horticultural smuggling also provide pathways for a variety of pests.

Slide 19 Forestry ISPMs
Towards the end of the twentieth century, regulatory systems worldwide were becoming overwhelmed with the increasing volume of international trade. What have we done about this? In an effort to control the spread of invasive pests, in 2002 the FAO-based Interim Commission on Phytosanitary Measures adopted a global standard for treating wood packaging material: International Standard for Phytosanitary Measures No. 15 (ISPM 15), “Guidelines for regulating wood packaging material in international trade”.

Slide 20 Pest introductions that resulted in ISPM No 15
Some of the major international movements of pests that increased global concern about this particular pathway are highlighted in this slide.

Slide 21 Potential, emerging or establishing pest problems in Europe
However, pest problems are still occurring in the European Plant Protection Organisation (EPPO) region especially associated with the import of plants for planting. Many potential threats are on the EPPO A1, A2 and Alert List (the latter are marked in bold). Some pathogens are highlighted here but I will not discuss them all in depth. I will however, use the following example as a prediction for what may occur when a new pathogen is introduced into a new environment.

Slide 22 New invasive pathogens
Infected Japanese larch, a new host of *Phytophthora ramorum*. In the close up you can see needle death and stem lesions. Infection appears to move from the outside in, and top down, suggesting aerial transmission.
Recent photograph of a mature stand with lots of dead/dying trees, and a similar shot taken in California. Are we heading this way in Europe?

Slide 23 Potential, emerging or establishing pest problems in Europe
This slide includes some of the potentially serious insect threats to European forests. Again, I will not go into any detail about all of these insects but have chosen the example of the citrus longhorned beetle as it has an interesting pathway. I suggest that for further information on these pests you refer to the EPPO website.

Slide 24 Anoplophora chinensis imported on bonsai
I have included this example of the citrus longhorned beetle as it represents a pest introduction into Europe through the importation of bonsai from Japan.

Slide 25 Emerging and establishing pest problems in Europe
The pine wilt nematode, the casual agent of pine wilt disease, is an interesting example of an organism that is not considered a serious pest in its native range of North America. It is however, considered to be a major threat to Asian and European pine forests where it has been introduced and it has resulted in extensive tree mortality. There is an EPPO Standard PM 9/1.

Slide 26 Potential costs of current trade restrictions
This is a hypothetical scenario of a pest incursion into New Zealand. Note that the same fungus species is now on the EPPO Alert list. And we must also remember how pine wilt nematode, just mentioned, resulted in trade implications for the export of pines from Portugal.

Slide 27 Forest-related standards currently being developed
The Commission on Phytosanitary Measures has approved a Technical Panel on Forest Quarantine which develops forest related standards such as these listed.

Slide 28 Guide to forestry and international phytosanitary standards
A multi-stakeholder publication is now being developed to provide the forestry sector with clear and concise guidance on forest health practices. Plain language descriptions of the international standards are included and suggestions for improved national implementation.

Slide 29 Global impacts of climate change
The second component of this presentation is climate change, and consequences in terms of modified habitats, and changes in hospitability to both indigenous and invading organisms.

Here we see some key findings of the IPPC on the impact of climate change on forests and environment. Changes in the pattern of disturbances by forest pests are expected under changing climate as a result of warmer temperatures, changes in precipitation, increased drought frequency and higher CO2 concentrations. These changes will play a major role in shaping the world's forests and forest sector.

Slide 30 Response of insects and pathogens to climate change
Pests may be the first predictors of climate change due to their ability to change more rapidly than tree populations.

Slide 31 Changed relationship between pest, environment and other species
Climate change is predicted to increase the likelihood of pest establishment in new locations- also to increase the severity of impacts of both native and introduced pests. This is likely to arise from the inter-related effects of physiological changes in pests and host trees. The overall response is dependent on changes in the pest-tree host- natural enemy relationship.

Slide 32 Increased temperatures - the main driver of change
The impact of climate change will be dependent on climatic zone:
- in temperate regions there will be decreased winter survival;
- while in boreal and polar regions a greater impact is anticipated and extended summer seasons will probably result in an increase in growth and reproduction.
Tropical insects already have very narrow ranges of climatic suitability compared to higher latitude species and are living very close to their optimal temperature, thus warming could be an extinction factor. Some impacts may be beneficial in protecting forest health e.g. increased winter mortality due to thin snow cover and slower larval development. Conversely some impacts may be detrimental such as accelerated insect development rate and range expansion of pests.

Slide 33 Example of early spring emergence DPR Korea
I would like to share with you my first hand experience of the effects of decreased winter temperatures and snow level in DPR Korea. Severity of outbreaks of the indigenous insect pest, *Dendrolimus spectabalis* have increased over the last few years due in part to increased winter temperatures resulting in earlier spring emergence – up to 10 days earlier- emerging caterpillars feed on last years needles on the lower branches thus synchrony with bud break is not critical. More than 100,000 ha. of the native host *Pinus densiflora* are now infested. Winter of 2008 was so mild that some caterpillars did not go underground but overwintered in bark crevices. More than 300 tons of caterpillars were hand-collected in a four-month period in 2007.

Slide 34 Consequences for pathogen distribution in Europe
Examples of forest pest species that have responded or are predicted to respond to climate change by altering distribution include two pathogens endemic to Europe shown here.

Slide 35 Consequences for insect distribution in Europe
Due to increased mobility, insects will generally respond faster than pathogens. Climate plays a major role in defining distribution limits of insects - limits are shifting as species expand into higher latitudes and altitudes and disappear from areas that have become climatically unsuitable. Notable in species whose distribution are limited by temperatures such as many temperate and northern species.

Slide 36 Changing distribution - Pine processionary moth
There is a large number of examples in the literature of insect distributions changing in response to climate change. This is an example, the Pine processionary moth, in France.

Slide 37 Changing distribution - Oak processionary moth
A southern and central European species that has moved north during the latter half of the 20th century. Very damaging to oak species, with notable episodes of defoliation in the Netherlands since it arrived in early 1990s.

Slide 38 Effects of changes in rainfall pattern
Precipitation can be a very important factor in the epidemiology of many pathogens as shown by the example of *Mycosphaerella pini* which depends on moisture for dispersal. Prolonged water stress may lower host tree resistance and make them more prone to pests. Sugar concentration in foliage can increase under drought conditions making them more palatable to herbivores- resulting in increased damage. Also drought stressed trees may increase their temperature by up to 4ºC which benefits fecundity and survival of insects.

Slide 39 Example of flooding effects
I talked about drought but flooding also has impact on tree physiology. The example shown is in southern Chile where flooding has resulted in large scale decline of native *Nothofagus* spp. The trees are now a suitable host for the bark beetle *Gnathotrupes* spp. which is thought to be implicated in disease transmission and subsequent death of the trees - the larval galleries are shown in the insert.

Slide 40 Effects of increased atmospheric CO2
Higher atmospheric CO2 results in improved growth rates and water use efficiency of plants and trees. This leads to lower nitrogen concentrations in trees and thus reduces nutritional value of vegetation to insects- insects may thus increase feeding. Changes in plant structure may occur – there may be increased leaf area, thickness, more leaves, larger diameter stems and branches- there may also be an increase in defensive chemicals. Both influence palatability. For example: the winter moth consumes more oak due to a reduction in leaf toughness-while the gypsy moth requires longer time to develop due to the increase in tannins.

Slide 41 Effects of extreme weather events
Climate change may affect frequency and intensity of other extreme climate-related events and thus impact on forest health. Direct damage to trees or alteration in ecosystems may increase susceptibility to pest outbreaks. Windstorms and lightening strikes can damage trees and allow entry of pathogens and secondary insect pests, plus mechanical breakdown of normal physiological function. Some examples of recent storm damage in Europe: the November 2004 windstorm resulted in 5.3 million m^3 approx 30 thousand ha. damage in Slovak Republic. Major storms in Netherlands in 2007 felled 250,000m^3 (0.4% standing volume).

Slide 42 Effects of increased warm air mass movements
Climate change is associated with increased warm air mass movement towards high latitudes- frequency and extent of long distance windborne dispersal events are likely to increase. The example I am using is taken from the agricultural sector. The probable source of the recent influx of the Diamondback moth on Svalbard Island in Norway, is 800 km north, in the Russian Federation.

Slide 43 What next?
Although climate change presents a global challenge, the influence on pest infestations is spatially and temporally constrained in their native range. Changes of range and severity are usually gradual. But increased global trade presents an increased opportunity for pest establishment in new locations remote from their native range.

Slide 44 What needs to be done

Slide 45 Be aware and be prepared