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NEWSLINE Forest Products Laboratory

FPL's Work with Global Climate Change

By Madelon Wise, Technical Publications Editor

Everywhere we go these days, we hear about climate change. But what does the term mean? Climate change refers to changes in our long-term weather patterns and in the environment caused by increasing levels of carbon dioxide and other greenhouse gases (GHGs) released into the atmosphere. The primary cause of GHGs, which trap heat that would otherwise radiate back into space, is humans burning fossil fuels. (See sidebar)

Forest Service researchers have studied the effects of climate change and air pollutants on forests and grasslands for over 30 years, already identifying trends and subsequent effects on ecosystems across the United States. Exemplifying Forest Service involvement in this timely subject is Forest Products Laboratory (FPL) Director Chris Risbrudt's October trip to Beijing, China, where he presented on the role of research in global climate change at the Chinese Academy of Forestry's 50th Anniversary Ceremony and International Symposium of Heads of Forest Research Institutions. Reflecting on this experience, Risbrudt stated that leaders of all 16 countries represented would agree that "An effective way to deal with accumulation of carbon dioxide in the atmosphere is to store it in forest products, such as houses. We must also recycle carbon dioxide in the atmosphere by using biofuels instead of adding carbon to the atmosphere by burning fossil fuels."

That the Forest Service is a leader in climate change research was borne out when 13 Forest Service scientists who worked with the United Nations' Intergovernmental Panel on Climate Change (IPCC) were awarded the Nobel Peace Prize for 2007 along with Al Gore, Jr. Ken Skog, project leader and scientist for the Economics and Statistics Research group at the FPL, was among these distinguished Forest Service scientists, and NewsLine recently spoke with him. Forest Products Laboratory research is contributing significantly to the climate change effort, and in our interview with Ken Skog, we learned the extent to which Skog and his group are involved in climate change research, which Skog says, "Is the better part of my work."

According to Skog, "The Forest Service strategy for climate change involves two broad-based strategies: adaptation and mitigation." Adaptation strategies aim to prepare the landscape and its habitants for the new climate, whereas mitigation strategies attempt to slow down the process of climate change. Mitigation involves undertaking activities aimed at reducing the extent of accumulation of GHGs in the atmosphere, and it is in this arena that most FPL research concentrates.

One example of mitigation is substantially offsetting emissions of GHGs by implementing technologies to use small-diameter timber, which aids in reducing fire hazards and in turn reduces GHG emissions from wildfire.

Transportation accounts for about a third of total U.S. emissions of carbon dioxide. Trees are one of the best potential sources of biofuels and FPL is a leader in research on forest biomass to energy production.

> *"Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture."*
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> Climate Change 2007—The Physical Science Basis Contribution of Working Group I to the Fourth Assessment Report of the IPPC

Using and creating markets for small-diameter material and low-valued trees removed from forest restoration activities is the business of the Forest Service Biomass Utilization Grants program administered by the Technology Marketing Unit housed at FPL. This innovative program is intended to help improve forest restoration efforts by such activities as reducing hazardous fuels, handling insect and diseased conditions, or treating forestlands affected by catastrophic weather events. These funds are targeted to help communities, entrepreneurs, and others turn residues from forest restoration activities into marketable forest products and energy products. FPL researchers are continually evaluating the economic effectiveness of projects funded under the grants program. Examples of small-diameter technologies include using round timbers for buildings, generating power from wood scraps with a Biomax, small-scale wood heating with the Fuel for Schools program, and improved harvesting systems.

(continued on pg. 3)

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We get thousands of inquiries each year. We print what we feel are some of the best questions Here is one we recently received.

I've recently read about damaging insects being spread by moving firewood. Is my home at risk if I unknowingly bring infested firewood inside?

By Rebecca Wallace,
Public Affairs Specialist

Improper handling and storage of firewood can cause a multitude of problems, but most insects emerging from firewood will not infest or cause damage to a home or structure. Storing firewood outdoors and bringing it inside no more than a few days before it is used should keep any insects entering your home to a minimum. Also, because firewood is burned, it should not be treated with any chemicals or insecticides.

The threat you've been reading about likely relates to the dangers of relocating firewood that is infested with significant insect pest species, such as the Asian longhorned beetle, which has devastated many native hardwood trees in the United States, or the emerald ash borer, which has caused the mortality of millions of healthy ash trees in both urban and forested environments. Here in Wisconsin, the emerald ash borer has been found in three counties, and all infestations are likely due to the transportation of infested wood products.

Something as seemingly insignificant as purchasing or collecting firewood can cause the introduction and spread of these destructive pests. Following these two simple rules can help avoid additional infestations:

1. Buy firewood where it is produced and where it will be used.

2. Do not transport or store firewood outside the local area (a 50-mile radius).

The 2007 United Nations Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) provides the most substantive and authoritative support for human-caused global climate change to date. This report, based mostly on peer-reviewed and published scientific literature, states that "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level." The report further states that, "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

Climate Change 2007—The Physical Science Basis Contribution of Working Group I to the Fourth Assessment Report of the IPPC

Another area of mitigation research is transportation fuel, which accounts for about a third of total U.S. emissions of carbon dioxide. Historically, the greatest increases in energy demand have been for transportation fuels, and known fossil fuel reserves are declining. Fossil fuel combustion is steadily increasing the concentration of carbon dioxide and other GHGs in the atmosphere. Computer models predict that changes in atmospheric composition will increase global temperatures and continue to cause profound changes in weather patterns.

At the same time that our need for alternative fuels becomes more pressing, large areas of forest lands are littered with an unnatural accumulation of stunted trees and woody debris. Decades of fire suppression have disrupted the natural fire cycle of U.S. forests. Fires on these overstocked stands are more intense and harder to control than forest fires in previous decades, and they contribute substantially to GHGs. Using these accumulated forest materials to create cleaner transportation fuels could play an important role in addressing climate change.

Trees are one of the best potential sources of biological fuel, although they present some challenges because of the difficulty of extracting energy from lignocellulose, the principal material component of trees. To break down stubborn lignocellulose, woody biomass is generally pretreated during ethanol production. The work of FPL scientists brings the process of converting woody biomass to fuel closer to reality. Although more challenging than creating biofuel from agricultural matter, converting wood resources to liquid fuels and chemical feedstock is becoming more cost competitive, and FPL is a leader in innovative research on forest biomass to energy production. Along with our concerns about climate change, exciting new opportunities are emerging for meeting global energy needs and simultaneously creating high-value bio-based products.

FPL economist Peter Ince and others are evaluating business cases for making biofuels using selected biochemical and thermochemical technologies. These include evaluation of extracting hemicellulose from wood at pulp mills prior to pulping and converting it to ethanol, and evaluation of a process to gasify wood and convert it to fuels such as biodiesel.

Biofuels

FPL is working on biofuel research on several fronts: Woodchip pretreatments to enhance biochemical conversions, Hemicellulose extraction from woodchips prior to pulping, Yeast for fermentation of five carbon sugars and mixed five/six carbon sugars, Novel conversion processing to produce biofuels and chemical feedstocks, Novel thermochemical conversion technologies, Process modeling, Economic and Business Case models for thermal and biochemical conversion.

Skog serves on another team that is also evaluating the potential for biofuels. The team includes researchers from the University of California-Davis, the U.S. Department of Energy, the U.S. Forest Service, and the Oak Ridge National Lab. This is a national study to identify optimal locations for biofuels plants that will use wood and agricultural feedstocks throughout the United States.

An additional team formed by the Forest Service with leadership from the University of Washington will provide a life-cycle inventory for producing biofuels from wood. The study will determine, in part, how much fossil energy use and GHG emissions are associated with wood biofuels production and other wood energy production. This information is needed to know how wood biofuels technologies can meet standards and targets to produce biofuels under the 2007 Energy Independence and Security Act.

Skog says that another significant mitigation technique is to "Develop more durable long-lived housing systems that store carbon for a longer time." The Consortium for Research on Renewable Industrial Materials (CORRIM), of which Skog is a member, is a not-for-profit consortium of 15 research institutions studying the environmental effects of producing and using wood-based building products. Skog explains that a CORRIM life-cycle assessment considers "The entire cycle from taking the wood out of forest, to making products, to building, running, and disposing of a house."

One activity of CORRIM is to compare different kinds of houses, such as an all wood house and houses built with steel or concrete components. Current research shows that wood houses result in less energy emissions and similar waste. CORRIM research also shows 26% and 31% greater global warming potential for steel and concrete buildings, respectively, than for wood frame buildings. By substituting wood for steel or concrete, less GHG emissions result.

The FPL is also collaborating with CORRIM to evaluate the most effective ways that forest management regimes, product use, and wood fuel use can offset GHG emissions. GHG offsets result from carbon storage in forests, wildfire emission reduction, carbon storage in wood products, wood energy use in place of fossil fuels, and substitution of wood products for products that call for more emissions in their production.

These are but a part of the research activities Skog and other FPL scientists are conducting around climate change. As you can see by the multidisciplinary and far-reaching science at FPL, we are working on many levels to grapple with the problems and opportunities brought at this crucial time in history.

FPL Scientist Profile

Carol Clausen

Editor's note: Periodically in NewsLine we feature an FPL researcher who has made significant contributions in their area of research. In this issue we meet Carol Clausen, Project Leader for FPL's Durability and Wood Protection research work unit since 2004. Carol received her M.S. in Bacteriology in 1983 from the University of Wisconsin–Madison. She started at FPL in 1984 as a Microbiologist, and became a Research Microbiologist in 1997. Carol's research specializes in biodeterioration and protection of wood, with an emphasis on inhibition of mold growth on wood-based building products.

Moisture in buildings has garnered a lot of attention in the press over the past few years, especially when it results in mold growth. Do you think that moisture intrusion and mold growth in buildings is more prevalent than it was in the past? If so, what do you see as the main contributing factor? Also, if a moisture problem causes mold growth, how common is it to actually be toxic?

When a subject such as mold gets abundant media attention, it's really difficult to say whether mold issues are actually more prevalent now than they were in the past. Based on the number of questions I get from contractors, builders, and homeowners alike, it appears to be more prevalent. Because the source of mold growth is always excess moisture, it is important to determine the source of the moisture problem and correct it. Faulty design and improper installation and handling of building materials are some of the more common reasons for chronic moisture problems, but many other potential sources of moisture could result in mold growth. The builder or homeowner is often not equipped with the knowledge to diagnose the cause of the problem. So, education is an important aspect of my job.

When we hear about toxic black mold in the news, they are referring to a mold fungus called *Stachybotrys ("stack-e-botris")*. Although *Stachybotrys* does produce toxic compounds, occurrence of this fungus is not common and is usually associated with very wet conditions, such as flooding, on cellulose products like the paper face of drywall. A more common health problem related to mold growth is an allergic response to the spores of several types of mold that can grow in 24 to 48 hours when ever excess moisture occurs without rapid drying.

Some of your research focuses on mold inhibitors, or preventing the problem before it gets started. Tell us about that.

Although there is no substitute for proper building and maintenance practices, my interest in developing mold inhibitors for wood products is intended to provide an added layer of protection from the types of wetting events that occur during building product storage, distribution, and inevitable construction delays. New structures have abnormally high moisture content during the period of time when the concrete foundation is curing and wet blown-cellulose insulation, drywall tape, and paint are drying. A mold inhibitor incorporated into construction materials would provide the new homeowner with added reassurance that their home is protected from mold establishment during this time.

Clausen's eary detection test kit can detect decay and stop it before it has a chance to cause irreparable damage to wood.

A few years ago, you developed an early detection testing kit for mold. Tell us how it works. Has there been any effort to commercialize this technology?

The early detection kit is actually for decay fungi, not mold, the difference being that decay fungi cause serious structural damage to wood. The test works by causing a color change to a test cassette if a particular enzyme that the decay fungus makes is present. Because the fungus produces this enzyme very early in the decay process, the test can be used to detect decay early and stop it before it has a chance to cause irreparable damage to the wood. It can also help define an area of damage to prevent unnecessary replacement of wood that might still be structurally sound. There has been a great deal of effort to develop a prototype and commercialize this product. Hundreds of samples of the prototype test were given away at trade shows and conferences. The prototype test cassette closely resembled an early pregnancy test, so although everyone wanted a free sample to try, they wanted it clearly labeled in case they had to explain what it was to family and colleagues. Despite two licensing attempts for the patent, it has not been commercialized; but hardly a week goes by that someone doesn't call the lab asking where they can purchase this test. This is the research project that I am most proud of, and nothing would be more rewarding than to see it available in the marketplace.

Moisture isn't the only home attacker that your unit studies. Termites are a scourge to many homeowners in the Southern part of the country. Wisconsin isn't exactly known to be a termite hotbed, but recently some of your team was involved with helping a small community north of Madison use a new approach to combat an infestation. Can you tell us about the infestation, what technique your scientists used to attack the colony, and why the results look so promising?

The infestation in Endeavor, Wisconsin, is unique because it occurred about 100 miles north of where you might expect termites to survive the Wisconsin winter. The termites are able to survive in the underground corridor of water mains and sewer pipes in that community. First, scientists defined the size of the colony by attracting the termites to bait stations

containing food. Now, they are using commercial termite treatments to eradicate the colony. The success of this effort is attributed to a community-wide eradication effort instead of the usual house-by-house eradication process, where only small pockets of termites are eliminated. Community leaders initially contacted FPL because municipal buildings were infested and FPL partnered with Alternative Pest Solutions (APS) to develop a multi-year community-wide control program. APS provides free home inspections. If termites are found and the homeowner cannot afford treatment, the village has obtained a block grant to pay for the service.

The residential ban on using wood treated with copper chromated arsenate (CCA) has caused the industry to look for more environmentally preferable forms of wood protection. Can you tell us about some of the more common options on the market, how effective they are for different uses, and if there are other promising options on the horizon?

Since the withdrawal of CCA-treated wood for residential use at the end of 2003, copper-based preservatives such as copper quat (known as ACQ), copper azole, and micronized copper have taken over the residential treated-wood market. They effectively protect wood from deterioration, but there are special recommendations concerning accelerated corrosion of metal fasteners when these products are used for structurally critical applications; fasteners should be hot-dipped galvanized or stainless steel. A number of promising new preservatives are on the horizon being developed both at FPL and by the industry that do not rely on copper or other metals. The next generation of metal-free preservative treatments will undoubtedly be more environmentally friendly.

One final question. When treated wood comes out of service, there is an environmental concern of how to dispose of it properly. Part of your unit's work is to look at environmentally sound ways to dispose of treated wood. What techniques have shown the most promise?

A number of techniques have been developed to chemically and biologically remove chromated-copper arsenate (CCA) from treated wood with varying degrees of success. My approach was to partially extract the copper, chromium, and arsenic from ground or flaked wood with an acid, followed by treatment with a bacterium that was quite tolerant of the toxic components in the preservative. Yes, this bacterium even survives in the presence of arsenic! My process removed 80% to 100% of the CCA, and I was then able to fabricate the "cleaned" flakes or particles into other products, such as particleboard or flakeboard. More recently, improvements to the acid extraction have significantly reduced the amount of time needed to extract CCA. But unfortunately, these technologies are not economically feasible as long as treated wood can readily be disposed of in landfills. In the event that landfill restrictions change, several proven technologies will be available to convert this waste into useful secondary products.

For more information on these and many other topics, check out FPL's Durability and Wood Protection website at http://www.fpl.fs.fed.us/rwu4723/index.html or FPL's main page at www.fpl.fs.fed.us

Major League Baseball Teams Up with Forest Products Laboratory

By Rebecca Wallace, Public Affairs Specialist

Watch any Major League Baseball game and you're likely to see a bat or two break on impact with the ball. Breakage of bats during play has become a safety concern for Major League Baseball (MLB), and Dave Kretschmann, research engineer at the Forest Products Laboratory (FPL), is on board to help improve the situation. Kretschmann has been giving technical advice to MLB officials on the mechanical properties of various species of wood commonly used to make baseball bats, and a contract between FPL and MLB has been signed to continue the partnership.

Between July 2 and September 7, Major League Baseball authenticators collected every bat broken during games—more than 1,700 bats! The committee compiled relevant information for each broken bat, including manufacturer, model, dimensions, game situation when it broke, area in which the bat fragments landed, and video footage of each incident. FPL will be working with TECO, a certification and testing agency, to help assess and categorize the bat failures, which is a first step toward reducing future catastrophic incidents.

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Wood you Believe...

- Did you know that wood is an excellent building product? The average single-family home (2,000 sq.ft) can contain 16,900 board feet of lumber and up to 10,000 square feet of panel products. Inch to inch, wood is 16 times more efficient as an insulator than concrete, 415 times as efficient as steel, and 2,000 times as efficient as aluminum. http://www.safnet.org/aboutforestry/funfacts.cfm
- What types of products are made from wood? - There are an estimated 5,000 different products made from trees. Apart from the well known products such as lumber, paper, and garden mulch, trees are responsible for other day to day items such as clothing, carpeting, and even toothpaste. http://www.safnet.org/aboutforestry/funfacts.cfm

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