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Climate Change and the Land Sector:

Improving Measurement, Mitigation and Resilience of our Natural Resources

DECEMBER 2015

Abbreviations and Acronyms

AFOLU	Agriculture, Forestry, and Other Land Use
ARMS	Agricultural Resource Management Surveys
BLM	Bureau of Land Management
CEAP	Conservation Effects Assessment Project
CH_4	methane
CNRWG	Climate and Natural Resources Working Group
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CRP	Conservation Reserve Program
CTIC	Conservation Technology Information Center
DOD	United States Department of Defense
DOI	United States Department of the Interior
EOP	Executive Office of the President
EPA	United States Environmental Protection Agency
FCAF	Forest Carbon Accounting Framework
FEMA	Federal Emergency Management Agency
FIA	Forest Inventory and Analysis
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
km	kilometer
LULUCF	Land Use, Land-Use Change, and Forestry
MMT	million metric tons
N_2O	nitrous oxide
NASA	National Aeronautics and Space Administration
NASS	National Agriculture Statistics Service
NDRP	National Drought Resilience Partnership
NLCD	National Land Cover Data
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRI	National Resources Inventory
UNFCCC	United Nations Framework Convention on Climate Change
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United State Fish and Wildlife Service

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Executive Summary

America's land sector plays an important role in addressing the challenge of climate change by removing nearly 14 percent of total U.S. greenhouse gases from the atmosphere and serving as a natural buffer to protect communities against the impacts of climate change. At the same time, climate change is already affecting our nation's forests, agricultural lands, and rural and coastal communities through severe floods, sea level rise, extreme heat, drought, intense wildfires, and pests and disease. Recognizing the need to address this challenge, President Obama, in his *Climate Action Plan,* instructed agencies to identify new approaches to protect and restore America's forests, grasslands, and wetlands, and promote sustainable and climate-smart land management practices. Federal programs implemented and strengthened through the *Climate Action Plan* are driving down greenhouse gas (GHG) emissions, increasing carbon sinks, and preparing our country's natural resources and communities for the impacts of climate change. These programs are also improving the data and methods we use to measure and evaluate progress, while increasing our understanding of how land-sector emissions may change in the future.

Due to the complex and ever-changing nature of land sector carbon sinks and emissions, as well as the uncertain trajectory of climate change impacts on our natural resources, effectively addressing climate change in the land sector presents unique challenges that require a coordinated, multi-faceted effort by the U.S. government and other partners. Accordingly, multiple agencies have been working together to ensure that annual land sector emissions and carbon sinks can be adequately tracked in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (referred to hereinafter as the *Inventory*), and that improvements in the *Inventory* are used to improve projections of future potential emissions.

Planned and ongoing improvements to track and forecast emissions and sinks include:

❖ Filling data gaps in the inventory of Agriculture, Forestry, and Other Land Uses (AFOLU) by integrating existing agency data sets to better track emissions from land management and land-use change among croplands, grasslands, forests, wetlands, and urban settlements

❖ Improving modeling of land-use change and associated GHG emissions by integrating satellite data with national survey data

❖ Expanding collections of survey and field data to better track nitrous oxide, methane, and carbon dioxide emissions associated with agricultural production, livestock production, wildfires, and other management activities on croplands, grasslands, and rangelands

❖ Advancing forest carbon accounting methods and providing more timely assimilation of forestry data

❖ Developing a preliminary estimate of national carbon stocks and GHG emissions associated with coastal wetlands for future inclusion in reporting under the United Nations Framework Convention on Climate Change (UNFCCC)

This focused effort on *Inventory* improvements will help track progress made from mitigation activities, help inform policy on land-sector emissions, and also reduce uncertainty in estimates of past and projected emissions.

Mitigation efforts in the United States have focused on increasing carbon stocks and reducing net greenhouse gas emissions through sustainable, climate-smart land management in croplands, forests, and grasslands. Most notably, the U.S. Department of Agriculture (USDA) recently implemented 10 Building Blocks for Climate Smart Agriculture and Forestry that will reduce net emissions by about 120 million metric tons of CO_2 equivalent (MMTCO$_2$e) per year by 2025. The building blocks provide incentives for

voluntary implementation of climate-smart practices on private and public lands. These include actions to improve soil health, nutrient management, livestock management, conservation of sensitive lands, and stewardship of private and public forest lands. Additionally, private sector organizations have made great progress in assessing their emissions footprint and are developing tools to guide reductions in GHG emissions across natural resource supply chains.

Changes in climate are already a reality. In addition to mitigating emissions, adapting to climate change and promoting ecosystem and community resilience in the face of climate change is important to ensure a sustainable and secure future. Through the President's *Priority Agenda for Enhancing the Climate Resilience of America's Natural Resources*, federal agencies have committed to over 80 actions that support comprehensive land and water resilience. For example, through a new Resilient Lands and Water Initiative, seven flagship geographic locations are the focus of collaborative, landscape scale conservation and restoration efforts that aim to build resilience of those ecosystems to a changing climate. Agencies have developed tools and provided funding to communities to prepare and adapt to climate risks such as coastal erosion, sea level rise, drought, and wildfire. As called for in the *Priority Agenda*, the Administration has issued *Ecosystem Services Guidance* and promoted innovative 21st century infrastructure that integrates natural systems into community development. Finally, agencies have been modernizing federal programs to incorporate climate change considerations, including natural resources planning and management, land acquisition, and natural resource financial assistance programs.

This Progress Report on *Climate Change and the Land Sector* highlights how the Obama Administration is working to improve measurements of land sector emissions while also designing innovative programs that enhance climate mitigation and resilience in this sector. Through these sustained actions we are protecting our natural resources and the communities that rely on them.

Chapter 1. Improving the *Inventory of U.S. Greenhouse Gas Emissions and Sinks*

As part of our obligations under the UNFCCC, the United States submits an annual *Inventory of U.S. Greenhouse Gas Emissions and Sinks* (EPA 2015). The *Inventory* covers sectors under the UNFCCC reporting requirements, including: Energy; Industrial Processes and Product Use; Agriculture; Land Use, Land-use Change, and Forestry (LULUCF); and Waste. The United States has been committed to providing regular, transparent updates to the international community and continues to improve and update its methodologies, activity data, and reporting.

Since the release of *The President's Climate Action Plan* (EOP 2013a), the United States has made significant progress increasing the scope of carbon sources and sinks covered by our lands sector data while decreasing related measurement uncertainty. In addition to providing a better understanding of what is happening in our land-sector, these improvements allow both federal and non-federal land managers to identify areas of opportunity and track the progress of climate change mitigation programs. For example, better understanding of how farmers apply nitrogen fertilizer to fields informs both how much nitrous oxide is emitted to the atmosphere and how the United States can do more to reduce these emissions.

Compared to other sectors, estimating greenhouse gas emissions and removals from the AFOLU sector is particularly complex and involves incorporating numerous national surveys and data sources across multiple agencies including the National Resources Inventory (NRI), Forest Inventory and Analysis (FIA), Annual Census of Agriculture, National Agriculture Statistics Service (NASS) data, and Agricultural Resource Management Surveys (ARMS). Given the scale of this sector—which covers land use and management activities on forestland, cropland, grassland, wetlands, and settlements—efforts to reduce the uncertainty associated with AFOLU emissions and removals are challenging. However, under the President's leadership, the federal government is working across agencies and collaboratively to obtain needed data and update methods, thereby increasing the precision and decreasing uncertainty in the *Inventory*. Current progress and planned near-term actions are documented below.

Land Use Representation

Agencies have been working to obtain a more accurate and complete representation of the U.S. land base and associated carbon exchanges. Each year, lands transfer from forests to grasslands, from croplands to forests, from forests to settlements, and vice versa. These transfers impact U.S. emissions. The interagency effort to improve our tracking of estimates of land use and land-use change involves reconciling differences between the NRI and FIA survey data on non-federal land.

The new approach will allow the U.S. to fully meet methodological guidance established by the Intergovernmental Panel on Climate Change (IPCC) and UNFCCC reporting requirements that require tracking of land use and land-use conversion on an annual basis from 1990 to present. To achieve this, the new approach statistically compares historical NRI survey data for non-federal land with FIA data to develop more complete land conversion estimates among land categories. Since the NRI and the FIA differ in some aspects of their forest land definitions, the data will be reconciled by comparing and adjusting the NRI aggregate land area for forest land, grassland, and wetland. The new method will estimate land use based on NRI points, which are more statistically refined, rather than on aggregate.

The results will be verified using both NRI point and FIA plot level data. Satellite-derived National Land Cover Data (NLCD) are used to fill remaining data gaps that are not represented by survey data, including federal grasslands and interior Alaska. Additional work will be conducted to integrate the NLCD into the

land-use change estimates where appropriate by coordinating the definitions of land classes among FIA, NRI, and NLCD. Ongoing research at the US Geological Survey (USGS) is intended to provide annual land cover change information that could improve on the 5-year cycle of NLCD. These efforts will more strongly leverage satellite-based land cover change estimates in the land sector emissions estimates.

Croplands and Grasslands

Our nation's croplands and grasslands have a large role to play in climate solutions. Improved management of agricultural lands and grazing lands could lead to higher rates of soil carbon sequestration, improved soil health, decreased nutrient run-off, and reduced emissions of N_2O and CH_4. For those lands under long-term crop production, 23 MMTCO$_2$ were sequestered in soils[1] in 2013 – largely due to the conversion of cropland to hay production fields, reduction of bare-summer fallow areas in semi-arid areas, increase in the adoption of conservation tillage practices, and continued enrollment in the Conservation Reserve Program. Strengthening our understanding of the role soils play in GHG sequestration will allow us to advance soil management practices on U.S. croplands and grasslands that optimize carbon sequestration while improving soil health.

Cropland Management Data

The USDA and the Environmental Protection Agency (EPA) have been working collaboratively to improve carbon stock and emissions reporting for croplands by integrating new data sources (Table 1), including the Conservation Effects Assessment Project (CEAP) data. CEAP is a USDA survey that is used in watershed assessments to track changes in land management, but it also provides a previously untapped source of agricultural GHG-relevant activity data. For instance, data on tillage practices, fertilization, and residue management from CEAP can be used to improve GHG estimates for croplands.

An additional, planned improvement is to incorporate data on carbon exchanges from agroforestry activities. A multi-agency team is currently developing a new approach to include agroforestry systems in the *Inventory*. The Central Midwest and Great Plains regions will be implemented first as a test with the goal of improving the method and subsequently extending it to the entire lower-48 region in the future. It is anticipated that initial estimates of carbon stock changes from agroforestry will be included in the 2017 *Inventory*.

Grassland and Rangeland Data

There is an opportunity to augment rangeland data for the *Inventory* using data linked to the NRI. The USDA Natural Resources Conservation Service (NRCS) has collected rangeland data for a subset of NRI points on non-federal rangelands in the western U.S. from 1982 onwards. Indicators for rangeland production from the NRI on-site rangeland data will be useful in refining estimates of biomass inputs into the soil carbon pool. Like CEAP data, NRI on-site rangeland data can be scaled up to the national level with statistical methods. USDA is currently facilitating the transfer of the NRI on-site rangeland data for use in the *Inventory*.

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[1] Cropland soil carbon sequestration represents annual changes in the "cropland remaining cropland" category in the *Inventory* and does not include losses or gains in soil carbon occurring from the conversion of croplands to or from other land uses, nor does it include emissions associated with agricultural inputs (EPA 2015).

Table 1. Surveys that can provide information for the *Inventory* about practices and technologies that influence GHG emissions from croplands and grasslands.

Practice/Technology	Land Management Surveys				
	NRI	CEAP	ARMS	NASS/ Census	CTIC
Land Use Change, Crop Selection & Rotation					
Land Use Change	x	x			
Crop Rotation and Area	x	x			
Silage vs. Grain Harvest				x	
Cover Crops		x	x		x
Cropping Intensity		x			
Crop Variety Selection					
Planting/Harvest Dates		x			
Bare-Fallow	x	x			
Type of Hay		x		x	
Tillage & Residue Management					
Adoption of Tillage Practices (no-till, conventional till, reduced till)		x	x		x
Tillage Implements and Operation		x			
Residue Harvesting		x			
Residue Burning					
Residue Grazing		x			
Fertilization Management					
Mineral Fertilization Rates		x	x		
General Fertilizer Types (Urea, Anhydrous ammonium)		x			
Urease/Nitrification Inhibitors		x			
Slow-Release Fertilizers		x			
Variable Rate Fertilization		x			
Manure Amendment Rate and Type		x	x	x	
Placement/Application Method		x	x		
Timing of Fertilization		x	x		
Other Organic Amendments		x			
Irrigation/Drainage Management					
Area of Irrigation	x	x			
Amount of Irrigation		x			
Amount of Fertilizer within Irrigation		x			
Drainage Tiles Installed		x			
Other					
Conservation Reserve Program (CRP) and Special Categories	x	x			
Erosion Control		x			
Liming		x			
Manure Management		x	x		
Agroforestry/Perennial Crops		x			

Additionally, we are working to track carbon stock changes in grasslands associated with woody biomass. One ongoing effort is to account for changes in woody biomass for woodlands, formerly classified as forest land, but now included in the grassland category due to a change in the forest land definition. This effort is being completed using the NRI rangeland data set. A second effort will use high-resolution imagery

from the National Agricultural Imagery Program together with Landsat-5 Thematic Mapper satellite imagery to produce a technique for large-scale mapping of woody cover on semiarid rangelands. These new data will improve our knowledge of woody plant cover and subsequent changes in carbon stocks. It is expected that this improvement will be implemented in the 2017 or 2018 *Inventory*.

The *Inventory* does not account for any GHG fluxes on managed grasslands in Alaska. However, managed grasslands have now been spatially delineated in Alaska, due to an updated managed-land definition for the 2015 submission of the *Inventory*. A scoping meeting will investigate options for estimating carbon stock changes on grasslands in Alaska and the implications for emission trends. Agencies will explore the potential to correct for emissions associated with climate change in this region, such as the thawing of permafrost.

Estimates of Fire and Soil Amendments

While the *Inventory* currently includes methods to estimate direct emissions of non-CO_2 emissions (e.g., CH_4 and N_2O) from burning agricultural residues, it does not estimate the influence of these practices on soil carbon and soil N_2O emissions. Additionally, the *Inventory* does not currently estimate fire emissions from grasslands. Agencies are working to integrate datasets that provide spatial coverage of fires on croplands and grasslands into the current modeling framework. These improvements will allow the *Inventory* to capture fire emissions and changes in carbon and nitrogen inputs to the soil from burning of agricultural residues or grassland biomass, thereby improving soil CO_2 and N_2O emissions estimates. Federal agencies are developing a methodology to improve estimates of these emissions and plan to include them in the 2017 *Inventory*.

Improvements using updated management data will also be made to capture emissions from compost and manure additions to cropland and grassland. Currently, there is limited information about the types of manure and compost applied to farmland. U.S. government agencies are investigating how to incorporate the complex emissions from organic soil amendments in the modeling framework. The method will need to capture differences in soil turnover rates and indirect effects on plant productivity and decomposition processes. Following a literature review and consultations with subject matter experts, agencies will make a recommendation to develop the necessary data and implement it in the *Inventory*.

Estimates of Livestock Emissions

Livestock are an integral part of rangelands and can contribute to soil carbon changes and emissions of CH_4 and N_2O. Methane in particular is a greenhouse gas that is approximately 23 times more effective at trapping heat in the atmosphere than carbon dioxide. Enteric fermentation is the largest source of CH_4 in the U.S. and manure management is a significant source of CH_4 and N_2O emissions. The *Inventory* relies on older data on the regional distribution of animal waste management systems. These data are predominantly based on expert judgment rather than survey data. Survey data on this topic are available in existing national data sets, and a new effort is underway to use these data for emissions reporting efforts.

Forest Lands

Forests, including vegetation, soils, and harvested wood, accounted for 89 percent of total net carbon sequestration in 2013. This was a result of net forest growth and increasing forest area. Accurately estimating carbon stock changes in our nation's forests and understanding the underlying drivers of these changes is critical to reducing net emissions, understanding implications of land management decisions, and meeting international climate targets.

Advancements in Forest Carbon Accounting

Data collected by FIA across all U.S. forests provides objective estimates of the numerous ecosystem services of forests including timber, carbon sequestration, wildlife habitat, soil health, water quality, and air quality. The U.S. Forest Service (USFS) updated its accounting methodology which will be incorporated in the 2016 *Inventory*. The new Forest Carbon Accounting Framework (FCAF) allows for rapid assimilation of emerging information and future technical developments (Woodall et al. 2015). For 2016, the FCAF will be able to identify the drivers of forest carbon stock changes, including land-use change, forest stand age, wildfires, and pest outbreaks, as well as refine estimates of soil organic carbon in forests. Beyond 2016, recent investments in field data collection and associated research will reduce the uncertainty associated with the nation's forest carbon baseline. For example, USFS has developed a plan to accelerate the establishment and re-measurement of western FIA plots to reduce uncertainty in forest carbon reporting. The FCAF at its core relies on annual measurement of a portion of FIA's plot network. However, a long re-measurement cycle in the western U.S. has led to the incorporation of many assumptions in FCAF, such as static rates of land-use change. The plan to update data for western forest plots will be implemented over approximately five years, and will reduce uncertainty associated with the U.S. forest carbon.

Beyond measuring the heights and diameters of trees across FIA's plot network, agencies and their partners have been refining techniques to measure the carbon pools associated with various ecosystem attributes, such as downed dead wood, understory vegetation, soils, and the forest floor which have been incorporated into the *Inventory* over the last five years (Table 2).

Table 2. *Inventory* improvements on forest lands.

Inventory Year	Forest Carbon Category	Improvement
2010	Living trees	Volume and biomass estimation techniques [2]
2011	Dead trees	Updated model with nationwide inventory data [3]
		Volume and biomass estimation techniques
2013	Downed dead trees	Incorporated national field inventory data into modeling [4]
2014	Leaf litter	Refined density modeling with nearly nationwide field data
2016 +	Belowground biomass	*Expected*: Biomass estimation techniques and inventory data
	Soil organic carbon	
	Understory vegetation [5]	
	Foliage	

In addition, the USFS is taking its regional timber product output to a national scale and updating it with a focus on more timely and consistent statistics for harvested wood product mixes. This program is conducted in concert with state partners across the nation with periodic surveys of primary wood producing facilities and annual surveys of pulpmills. This program also conducts a systematic survey of wood utilization on logging sites across the nation that informs calculation of harvest residues and

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[2] (Domke et al. 2011)
[3] (Domke et al. 2011)
[4] (Domke et al. 2013)
[5] (Russell et al. 2014)

associated carbon stocks that remain in forests following harvest. This work will increase reporting accuracy for carbon in harvested wood products.

Creating an Inventory for Alaskan Forests

The boreal forests of interior Alaska may represent over a third of all forest carbon in the coterminous United States. However, it is the only area of forests not sampled by FIA's national plot network. Recent changes in classification of managed versus unmanaged lands in Alaska (Figure 1) establish a new need to quantify carbon sources and sinks in Alaska. The USFS initiated a pilot inventory in the Tanana Valley of interior Alaska in the summer of 2014 to evaluate a cost-effective inventory design to measure carbon stocks. Field measurement protocols specific to boreal forest conditions are being examined, and the USFS has built partnerships with a number of state and federal agencies to leverage resources and expertise for this pilot work:

❖ The National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center augmented the FIA sample with detailed measurements acquired from a LiDAR-hyperspectral-thermal airborne remote sensing instrument

❖ State of Alaska Division of Forestry (Tanana Valley State Forest) assisted with logistics planning and in-kind support

❖ University of Alaska, Fairbanks has been instrumental in logistics planning, protocol development and ground-access field plot data collection

❖ USFWS (Tetlin National Wildlife Refuge) aided with protocol development and ground plot location in the National Wildlife Refuge

Evaluation of both short- and long-term approaches for including interior Alaska in the *Inventory* continues. Methods that are adopted will depend on evaluation of the different estimation methods, while implementation and inclusion will depend largely on additional funding and resources.

Wetlands

Coastal wetlands provide shoreline protection from weather and erosion, filter runoff, improve water quality, provide unique wildlife habitat, and commonly have high carbon stocks because of their water saturated condition. Many coastal wetlands have been degraded due to historic development, but in recent years, federal and state officials have worked to restore these vital habitats. Global recognition of the importance of coastal wetlands and the need to quantify changes occurring in these ecosystems has prompted the international community to recommend inclusion of coastal wetlands in national emissions inventories.

In 2013, the IPCC released new guidelines to estimate GHG emissions and removals from wetlands. The guidelines also expand reporting categories to include carbon exchanges from drained organic soils, rewetted organic soils, coastal wetlands and inland wetland mineral soils. Parties to the UNFCCC were encouraged to begin implementing this new guidance and to report back on experiences and lessons learned by 2017, and the U.S. government intends to meet this goal (IPCC 2014).

The National Oceanic and Atmospheric Administration (NOAA), in close partnership with EPA, is leading U.S. efforts to incorporate GHG emissions and removals from coastal ecosystems into the *Inventory*. It is expected that the United States will meet Tier 1 level reporting, and possibly Tier 2 level for some activities, depending on the availability of country-specific data. To meet these goals, NOAA has established a new U.S. Coastal Wetlands Carbon Working Group, comprised of experts from the federal government and broader research community with expertise in coastal wetlands, carbon cycling, GHG

inventory development, land-use change monitoring and modeling, and coastal management. This effort will assist the EPA to incorporate results into the 2016 *Inventory* as an information item, with the goal of full reporting in the 2017 *Inventory*.
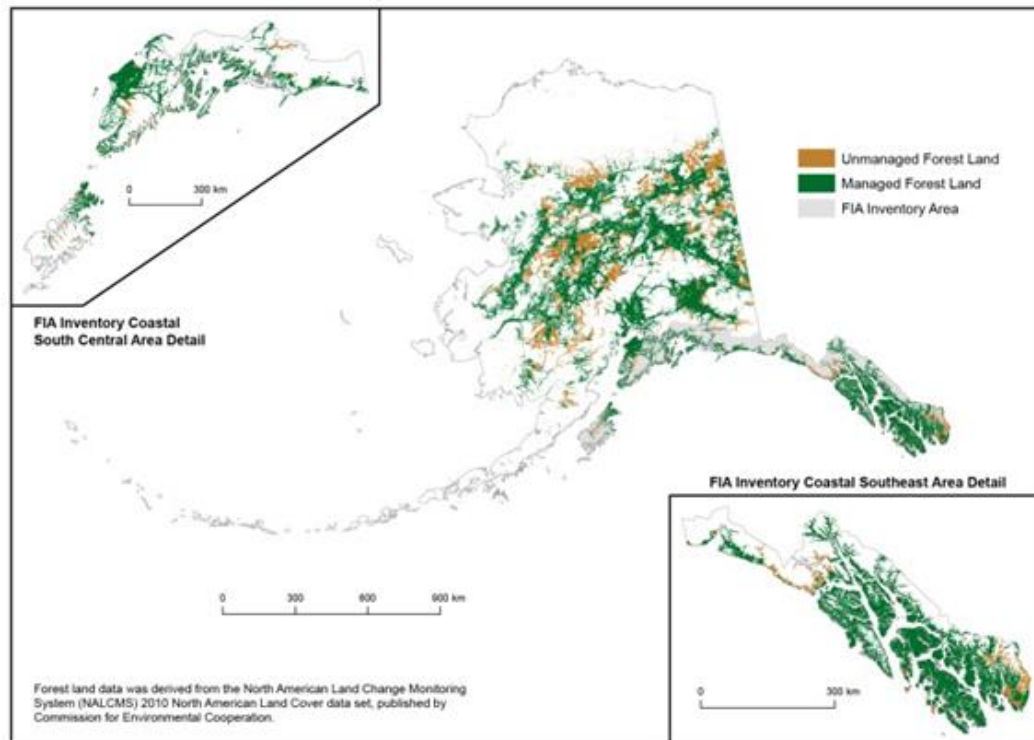
Figure 1. Delineation of managed and unmanaged forest land in interior Alaska in addition to south central and southeast coastal Alaska that are currently inventoried by FIA. *Source*: Woodall et al. 2015

Urban and Suburban Settlements

Currently, urban tree carbon is based on scattered urban tree inventories that often use varying field methods. The FIA has initiated an annual inventory of urban trees that will create a consistent approach for assessing these carbon stocks and fluxes as the program expands across metro areas nationwide. Since the urban tree inventory is conducted by the same technical staff as the forest inventory, there is a seamless transition across the rural to urban gradient for monitoring carbon stocks associated with trees. These improved methods will more accurately reflect the efficacy of urban tree programs and their potential for continued carbon sequestration.

Box 1: Summary of Completed Work to be Included in the 2016 *Inventory*

Several components of the aforementioned work-streams have been completed over the past year and will be incorporated in the 2016 *Inventory of U.S. Greenhouse Gas Emissions and Sinks* including*:*

❖ Adoption of a new Forest Carbon Accounting Framework to improve attribution of land use, land-use change, and disturbance across the *Inventory* time series (1990-2014), estimate of forest soil organic carbon based on nationwide *in situ* data, and implement corrections for missing historic data (Woodall et al. 2015)
❖ Accounting for carbon stock changes in soils on federal grasslands
❖ Preliminary estimates of carbon stock changes and non-CO_2 emissions from coastal wetlands
❖ Integrating survey data from the National Resources Inventory through 2010 to improve estimates of land cover change
❖ Updating the time series for satellite-based Enhanced Vegetation Index through 2010 to improve estimation of biomass production and carbon inputs to agricultural soils
❖ Replacing the 32 km-resolution weather data with 4 km-resolution weather data to improve local representation of temperature and precipitation drivers of biomass and soil emissions
❖ Updating soils attribute data with most recent database compiled by the National Cooperative Soil Survey
❖ Improved accounting of CH_4 emissions from rice cultivation and integration with other cropland fluxes

Chapter 2. Advancing Projections of Land Sector GHG Emissions and Carbon Sinks

In addition to enhancing our understanding of the lands sector, the U.S. government is advancing our capacity to project future GHG emissions from this sector (EOP 2013a). EPA, USDA, and other agencies have been working to develop tools that can generate business-as-usual baselines and different policy scenario projections of potential future LULUCF emissions and carbon storage on a biennial basis for 20-30 years into the future. This effort helps to improve our understanding of the longer-term cumulative impact of land management strategies on net emissions.

Estimating future GHG emissions from terrestrial ecosystems is complicated by uncertainty in projected land-use change, expected supply and demand of natural resource commodities, and related economic drivers. To estimate a range of emissions projections, the United States uses different models that have different sensitivities to future macroeconomic and environmental conditions. Using combined output from these model ensembles allows for a more robust range of projections, a more representative range of policy scenarios, a more precise estimation of uncertainty, and the ability to capture important interactions between climate policy and land use decisions in the United States and abroad.

Over the past two years, experts at both EPA and USDA have made significant progress in improving modeling of emissions trends in the AFOLU sector. Current and planned improvements are described in this section.

EPA Modeling and Projections

To support agency and U.S. initiatives, including the *Climate Action Plan*, EPA has been working toward achieving three primary goals to advance land sector GHG modeling tools and projections estimates. These three goals consist of:

❖ Enhancing existing land sector GHG projection efforts and resources that contribute toward a collective pool of knowledge,

❖ Developing an assessment of near- to mid-term LULUCF GHG fluxes, and

❖ Improving understanding of potential impacts of policies to enhance the land carbon sink and inform decisions about future policies.

EPA has conducted a survey of different economic and biophysical models used by various U.S. government agencies, as well as other academic and research institutions to establish an understanding of available modeling resources. Additionally, EPA has engaged with a variety of outside experts from academia and national research laboratories to develop a suite of modeling tools that generate baseline and policy scenario projections of potential future LULUCF emissions and carbon storage.

EPA's current forest sector modeling effort uses various types of models to generate a range of LULUCF projections, because the use of different model types in concert allows for a more robust range of projections. The EPA LULUCF modeling suite includes two global forestry and land-use models, a global integrated assessment model, and detailed U.S. forestry and agriculture models. EPA calibrates their models to specific global and U.S. macroeconomic projections and historic U.S. forest carbon stocks and fluxes, which allows them to generate projections of international forestry market conditions, U.S. economic and biophysical conditions, and drivers relevant to the LULUCF sector. The models are used to generate business-as-usual baselines and various alternative scenarios that assess the magnitude of impact of different input variables on projected outcomes. EPA's analysis also includes the simulation of different mitigation options and policy scenarios to estimate future mitigation potential in the United

States. Uncertainty analyses conducted in the EPA modeling effort have also illustrated how uncertainty in key model parameters, functionality, and expected macroeconomic conditions can lead to meaningful differences in CO_2 emissions and carbon stock projections from U.S. forestry.

EPA will continue developing its LULUCF modeling tools with baseline refinements, mitigation and other policy scenario evaluations, and incorporation of the aforementioned updates to land-sector inventory data as the improvements are completed. Future work will disaggregate results further, focusing on differences in drivers, such as age class structure, harvest, land use change, planting, forest species mix, and the hardwood/softwood distribution between scenarios.

USDA Modeling and Projections

In 2014, USDA established an interagency team to develop and implement a formal and transparent process for developing comprehensive and internally consistent projections for carbon exchanges in the AFOLU sectors. In constructing projections, USDA uses a composite methodology that combines information and insights obtained from:

- ❖ Forest and agricultural sector models used by the USFS and USDA's Economic Research Service

- ❖ Current and historical data on GHG emissions, CO_2 removals, population growth, and urbanization

- ❖ Recent assessments of current U.S. forest conditions and the trends that are likely to affect future conditions over the next several decades

- ❖ Recent projections of population growth, economic growth, and commodity market conditions developed by other U.S. government agencies

The 2015 USDA projections were improved upon and expanded to include additional scenarios and products (Table 3), including a reference scenario, a low-emissions scenario, and a high-emissions scenario. The reference scenario was constructed to evaluate how land use and GHG emissions pathways in the agriculture and forestry sectors might evolve over the next few decades, assuming a continuation of current conditions in key factors that could affect long-run changes in the markets for agricultural and forest products and current agricultural and forest sector policies. The low- and high-emissions scenarios incorporate variations in the rate of U.S. population growth and the demand for developed land uses. For U.S. agriculture, the key drivers affecting the overall level of commodity production – and the aggregate level of GHG emissions from U.S. food and fiber systems - are domestic and international population growth. For forestry, a key driver of emissions has been the net flow of land into and out of forest.

The reference, low-emissions, and high-emissions scenarios now include a specific set of projections related to commodity production. These projections were developed by extending a much broader set of variables contained in the USDA 10-year baseline than was done for the 2014 projections. By expanding these projections, USDA is providing a broader set of potential outcomes representing projections of land in crop production and emissions from agricultural sources.

Table 3. Projections developed for the USDA reference, low-emissions, and high-emissions scenarios.

Variables included in 2015 USDA Projection Scenarios		
Category	**Projection**	**Unit Projected**
U.S. Land Use & Land-use Change	Forest uses	Acres - Land in forest remaining forest & land transitioning into (or out of) forest
	Cropland (corn, wheat, soybeans, cotton, and other principle crops)	Acres - Planted & Harvested
	Developed Uses	Acres
	Other non-federal rural land (primarily grasslands)	
Agricultural commodity production - *crops*	Corn	Million bushels & Bushels per acre
	Wheat	
	Soybean	
	Cotton	Bales & Pounds per acre
Agricultural commodity production – *livestock*	Beef cattle	1,000 head & Million pounds
	Dairy cattle	
	Hogs	
	Poultry	Million pounds
GHG emissions and removals	Net flux from U.S. Forests	$MMTCO_2$
	Net flux from agricultural soils	
	Sequestration in harvest wood products	
	Sequestration in urban forests	
	Emissions from U.S. crop and livestock production systems	CH_4, N_2O (in $MMTCO_2e$)

Integrating model projections

The results of EPA and USDA models to generate U.S. projections of the land sector together represent a range of future land distributions and associated emissions and sinks. The different approaches reflected in each model, and their associated estimates of uncertainty, help give a more complete picture of what might happen in the U.S. land sector under alternative future scenarios. Alternate assumptions about the relationship of population and land use, for example, can lead to divergent outcomes in the land sector, and the approaches taken by the different models allow investigation of these outcomes. Similarly, uncertainties in specific parameters can lead to differences in outcome which can also be investigated with these approaches.

Chapter 3. Strategies to Mitigate GHG Emissions and Enhance Carbon Sinks in the Land Sector

The Obama Administration is committed to adopting mitigation strategies for reducing land-sector greenhouse gas emissions and increasing carbon removals from the atmosphere. The land sector plays an important role in managing net greenhouse gas emissions, because it has the ability to act as a sink or source of emissions depending on land management practices. In many cases, land management practices that reduce GHG emissions also improve soil health, increase the resilience forests and croplands to climate change, and improve water quality. These benefits contribute to the long-term sustainability of natural resources for both land managers and the nation.

U.S. government agencies are continually assessing potential opportunities to promote climate-smart land management and integrate climate change mitigation activities into existing programs. A number of land management activities have been identified and are currently being implemented to increase mitigation and sequestration from cropland production and forest conservation. Additionally, the United States is working with international partners and private sector leaders to advance mitigation programs in the land sector through collaboration on innovative technologies, effective land management strategies, and accounting methods to capture progress.

Progress Achieved through U.S. Government Programs

USDA Regional Climate Hubs and Outreach Efforts

USDA established seven Regional Climate Hubs and three Sub-Hubs in February 2014 to deliver science-based knowledge, practical information and guide stakeholders to programs that support implementation of climate change mitigation and adaptation activities. In October 2015, USDA released eight regional climate vulnerability assessments that provide land managers and agency partners with an introduction to regional sensitivities and strategies for climate mitigation and adaptation, including a greenhouse gas emissions profile with mitigation opportunities and an overview of how partner agencies are being affected by a changing climate.

Accessible technical resources, tools, and training modules are the foundation of the Hubs and other USDA outreach efforts. USDA has developed modules designed to keep producers and land managers in touch with the latest advances in science and technology and changes to best practices and policy. Several climate-smart decision-support tools are being used in the Climate Hubs. Using data grounded in the *Inventory*, NRCS and its partners created the user-friendly COMET-Farm tool that allows agricultural producers and forest landowners to explore the greenhouse gas implications of alternative management projects on their property (USDA 2015a). The Climate Hubs Toolshed, a suite of tools inventoried by the Hubs, is available to help growers mitigate their emissions and manage risk in the face of climate variability, including tools to visualize historical crop and climate data, determine feasibility and profitability of nitrogen application, and plan fieldwork activities.

Demonstration projects and access to local, trusted experts for technical assistance are crucial in outreach efforts to encourage adoption of new practices. Using local demonstrations and early case studies from adopters to build strong success stories will be an important component of promoting climate-smart agricultural practices. USDA encourages demonstration projects across the country through the NRCS Conservation Innovation Grants, a voluntary program to stimulate the development and adoption of innovative conservation program and technologies. The National Institute of Food and Agriculture also supports the Sustainable Agriculture Research and Education program, a decentralized competitive grants program with four regions that funds producers, educators, researchers, nonprofits, students, and

communities to advance innovations that improve profitability, stewardship, and quality of life through research, professional development, demonstrations, and education.

USDA Building Blocks for Climate Smart Agriculture and Forestry

In April 2015, Secretary of Agriculture Thomas Vilsack announced ten "Building Blocks for Climate Smart Agriculture and Forestry," which promote the voluntary adoption of GHG mitigating technologies and practices on working landscapes (USDA 2015b). They focus on a specific set of USDA's agricultural, forestry, and energy-related programs to encourage GHG reductions while also providing multiple economic and environmental co-benefits. USDA expects actions taken under the building blocks to mitigate over 120 MMTCO$_2$e per year by 2025. Box 2 provides details on the ten building blocks.

These building blocks will focus USDA's efforts to reduce net GHG emissions above and beyond what is already accomplished through its agriculture, forest, and energy programs. For example, USDA will make an additional 400,000 acres of highly environmentally sensitive land eligible for enrollment in its Conservation Reserve Program (CRP), thereby reducing expected emissions by 820,000 metric tons of CO$_2$e per year by 2025. In total, the CRP has helped farmers and ranchers prevent more than 9 billion of soil from eroding, reduce nitrogen and phosphorous runoff, and sequester 43 MMTCO$_2$e of greenhouse gases annually. Additionally, through the CRP, the Environmental Quality Incentive Program, and the Conservation Stewardship Program, USDA is working with farmers, ranchers and forest landowners to implement conservation practices that have reduced net greenhouse gas emissions by over 360 MMTCO$_2$e since 2009, or approximately 60 MMTCO$_2$e per year.

Implementation is already underway. USDA offices have incorporated the building blocks into their programs, and the changes are being communicated through the regional USDA Climate Hubs. As part of the building blocks process, USDA is working to incorporate these additional actions into its performance tracking and do so in a manner that is consistent with the *Inventory* reporting practices. Changes in the *Inventory* are expected to capture land management activities that are incentivized through the building blocks, such that local changes in land management are represented in national emissions estimates and subsequently communicated internationally.

Promoting Soil Health

The NRCS Soil Health Division has been created to educate and encourage producers to institute management practices that improve the health of agricultural soils by increasing carbon sequestration and decreasing net greenhouse gas emissions. The program will use a number of mechanisms that focus on conservation practices on working lands. An existing GHG estimation tool, along with databases from the NRCS Resource Economics and Analysis Division and other resources, will be used to quantify both increased impact of this program and subsequent carbon sequestration and net greenhouse gas emissions of participating producers.

U.S. Forest Service Carbon Report

The USFS is improving its management response for climate change mitigation and sustainable consumption activities. To help build forest carbon literacy within the agency, the USFS is developing a General Technical Report about the science of forest carbon, considerations in carbon management, evaluation of USFS directives, policies and programs with respect to carbon management, and guidelines for effective strategies and actions in a changing climate.

Box 2: Building Blocks for Climate Smart Agriculture and Forestry

- ❖ **Soil Health:** Improve soil resilience and increase productivity by promoting conservation tillage and no-till systems, planting cover crops, planting perennial forages, managing applications of organic inputs, and alleviating compaction.
- ❖ **Nitrogen Stewardship:** Focus on the right timing, type, placement, and quantity of nutrients to reduce nitrous oxide emissions and provide cost savings through efficient application.
- ❖ **Livestock Partnerships:** Expand the use of anaerobic digesters, lagoon covers, composting, and solids separators to reduce methane emissions from manure management. Over the next 10 years, USDA plans to support 500 new digesters and cover 10 percent of anaerobic lagoons on dairy and hog operations.
- ❖ **Conservation of Sensitive Lands:** Use the Conservation Reserve Program and the Agricultural Conservation Easement Program to reduce GHG emissions through riparian buffers, tree planting, and the conservation of wetlands and organic soils. By 2025, USDA aims to enroll 400,000 acres of CRP lands with high greenhouse gas benefits, protect 40,000 acres through easements, and gain additional benefits by transferring expiring CRP acres to permanent easements.
- ❖ **Grazing and Pasture Lands:** Support rotational grazing management, avoiding soil carbon loss through improved management of forage, soils and grazing livestock. By 2025, USDA plans to support improved grazing management on an additional 9 million acres, for a total of 27 million acres.
- ❖ **Private Forest Growth and Retention:** Through the Forest Legacy Program and the Community Forest and Open Space Conservation Program, protect almost 1 million additional acres of working landscapes.
- ❖ **Stewardship of Federal Forests:** Reforest areas damaged by wildfire, insects, or disease, and restore forests to increase their resilience to those disturbances. USDA plans to reforest 32,000 post-disturbance acres by 2025.
- ❖ **Promotion of Wood Products:** Increase the use of wood as a building material, to store additional carbon in buildings while offsetting the use of energy from fossil fuel. USDA plans to expand the number of wood building projects supported through cooperative agreements with partners and technical assistance, in addition to research and market promotion for new, innovative wood building products.
- ❖ **Urban Forests:** Encourage tree planting in urban areas to reduce energy costs, storm water runoff, and urban heat island effects while increasing carbon sequestration and property values. Working with partners, USDA plans to plant an average of 10,000 additional trees in urban areas per year through 2025.
- ❖ **Energy Generation and Efficiency:** Promote renewable energy technologies and improve energy efficiency in rural areas through the Energy Efficiency and Conservation Loan Program, the Rural Energy for America Program and other programs, the Environmental Quality Incentives Program, and Rural Housing Service Programs.

EPA AgSTAR Program

AgSTAR encourages the use of methane (biogas) recovery technologies at confined animal feeding operations that manage manure as liquids or slurries. These technologies reduce methane emissions while achieving other environmental benefits. The practices recommended under AgSTAR have been incorporated into USDA's broader technical, conservation and cost-share programs. AgSTAR also works at a national level to identify and address barriers to biogas recovery projects, as well as to provide information and training to state- and local-level agencies who permit projects, and the private sector organizations that implement them.

Key benefits promoted by AgSTAR include sustainable management of manure, reduced GHG emissions, and the development of value-added byproducts. Biogas recovery systems help reduce GHG emissions

by enabling the recovery and use of methane from animal manure and other organic wastes. A biogas recovery system is typically anchored by a manure digester that captures and combusts biogas to produce electricity, heat, or hot water. Anaerobic digesters reduce GHG emissions in two ways. The first is the direct methane emissions reduction from the capture and burning of biogas that otherwise would escape into the atmosphere from the waste management system. For projects that generate energy, a second benefit is the avoided GHG emissions (CO_2, CH_4, and N_2O) and other pollutants from the use of biogas to displace fossil fuels that otherwise would be used to generate energy. In addition to avoiding methane emissions, digester systems also reduce local water and air pollution, act as a source of renewable energy, provide rural economic development, better manage nutrients, and generate other value-added products (e.g., manure fibers) that improve farm revenues.

Public-Private Partnerships on Climate Change Mitigation

In June 2015, the White House hosted a roundtable discussion with businesses and organizations at which many participants announced new commitments to promote the adoption of agricultural practices that reduce GHG emissions and improve water quality and water-use efficiency (EOP 2015a).

Building on these commitments, some of the largest companies from in the U.S. economy have shown their support for a strong Paris outcome by setting ambitious targets for climate action (EOP 2015b). These additional pledges commit to reducing land sector emissions and enhancing carbon sequestration through greening supply chains, sourcing sustainable fibers, meat, soy, and palm oil, promoting climate-smart agriculture, strengthening conservation efforts, and reducing deforestation (Table 4).

Table 4. Independent private sector commitments for sustainable, climate-smart land management.

Company	Actions
Agile Sourcing Partners	Be ISO 14001 compliant in 2016 and reduce paper consumption 75% by 2017
Avery Dennison	Eliminate deforestation from the production of agricultural commodities by 2020, purchase 100% of paper from certified sources by 2025, and 70% from Forest Stewardship Council certified sources by 2025
Campos Brothers Farms	Reduce dust into the atmosphere 60% by 2025 and reduce water usage by at least an additional 10% (from a 33% reduction baseline) through irrigation technology
Cargill	Cut natural forest loss 50% by 2020 and strive to end it by 2030, build a transparent palm oil supply chain committed to no deforestation of high conservation value lands or high carbon stock area and no development on peat, implement Brazilian Soy Moratorium (net-zero deforestation), and more efficiently manage resources through sustainable beef partnerships
Coca-Cola	Engage with farmers representing 250,000 acres by 2015 and up to 1 million acres by 2020 (50% of their global corn supply) to rapidly expand application of Field-to-Market program to quantify GHG emissions and use of water, fertilizer, and energy
Cox Enterprises	Invest in sustainability and conservation through the Cox Conserves program and become both carbon and water neutral by 2044 through several action pledges
Dell	Plant 1 million trees by 2020 to help sequester carbon and restore habitats
Disney	Implement long-term goal of zero net greenhouse gas emissions, including actions to protect and rehabilitate forests
Dupont	Commit $10 billion by the end of 2020 to research and development of innovations to produce more food, enhance nutritional value, improve agriculture sustainability, boost food safety, extend food freshness, and reduce waste
Energy Optimizers, USA	Eliminate deforestation from the production of agricultural commodities by 2020

Environmental Defense Fund	Work with all actors in the commodity crop supply chain to implement fertilizer and soil health practices on a majority of acreage and install wetland filters on 2-3% of acres in Upper MS River Basin by 2030 to achieve 45% reduction in nutrient loading
Field to Market	Harmonize metrics to assess the sustainability of feed production, maximize interoperability among tools used to inform sustainable practices, and advance scientific research and communication
General Mills	Sustainably source 100% of top 10 ingredients (50% of total ingredient buy) and eliminate deforestation from the production of agricultural commodities by 2020
Hershey's	Trace 100% of palm oil purchases to the mill level by 2015 and to the plantation level by 2016, ensuring purchased palm is deforestation-free and grown and processed sustainably, and reduce absolute water use by an additional 25% by 2025
IKEA	Contribute to Forest Stewardship Council certification of an additional 10 million hectares of forest in priority areas (more than double the total area needed to supply IKEA) and source 100% of wood, paper and cardboard from more sustainable sources (currently defined as Forest Stewardship Council certified or recycled wood)
Innovation Center for U.S. Dairy	Reduce dairy sector emissions by 25% by 2020
International Flavors & Fragrances	Source all palm oil sustainably to ensure that their palm oil supply chain does not contribute to deforestation and peat clearance
International Paper	Commit to responsible forestry around the world and lead in the international effort to stop illegal logging and ensure timber legality in the global supply chain
Kaiser Permanente	Decrease the amount of meat per patient meal by 18% and increase the amount of locally grown, sustainably produced fruits and vegetables served to patients by 50%
Kellogg	Achieve zero net deforestation by 2020 in high-risk supply chains (soy, palm oil, timber, fiber and soy), and support 500,000 farmers through partnerships, research, and training on climate smart agriculture
Levi Strauss & Co	Ensure that no forest-based materials that originate from the world's ancient and endangered forests enter into their supply chain by 2020
L'Oreal	Source 100% renewable raw materials from sustainable sources and strive for "Zero Deforestation" by 2020, with 100% deforestation-free palm supply and 100% certified board and paper for packaging and promotional material
Mars	Continue to build on current deforestation policy, which covers the key raw materials in their supply chain (including palm oil, beef, pulp, paper and soy), and source only from producers and suppliers who agree to strict sourcing standards
McDonald's	Eliminate deforestation from their global supply chain by focusing initial efforts on beef, fiber-based packaging, palm oil, coffee, and soy used for beef & poultry feed, Begin purchasing a portion of their beef from verified, sustainable sources starting in 2016, By 2020, verify that 100% of the coffee and palm oil used in restaurants and ingredients comes from sustainable production systems and source 100% of fiber-based packaging from recycled or certified sources
Mondelez International	Address deforestation in key agricultural supply chains, with emphasis on palm oil and cocoa
Monsanto	Reduce crop protection GHG emissions by an additional 22% on a per product basis and increase irrigation water efficiency across operations, saving 30 to 80 billion gallons of fresh water per year by 2020 (baseline 2010)
National Corn Growers Association	Participate in Field to Market and administer the Soil Health Partnership to help expand the current SHP Demonstration Farm Network from 40 to 100 by 2018
National Label Company	Offer 100% sustainable raw materials that have zero net deforestation and that reduce material calipers up to 15%, and reduce corrugate consumption 15% by 2020

The Nature Conservancy	Help reduce nutrient loading in the Mississippi Basin 25% by 2025 by seeking and developing new funding resources to assist farmers and local communities, partnering with the private industry, and targeting resources to high priority areas
News Corp	Continue to purchase 100% of publication paper from mills whose forest management practices are certified
PepsiCo	Expand the use of sustainable farming practices to 500,000 acres of farmland used by North American agricultural suppliers in corn, oats, potato, and citrus supply chains by the end of 2016, and strive for zero deforestation in business operations and global supply chain by 2020
Proctor & Gamble	Build a traceable palm oil supply chain and ensure palm oil suppliers have implemented no deforestation policies and practices by 2020
PwC US	Purchase forestry offsets to continue to reduce the impact of air travel and support their local communities' environmental conservation efforts
Starbucks	Purchase 100% ethically sourced coffee through its C.A.F.E. Practices guidelines that increase fertilizer efficiency, prevent deforestation, and reduce water and energy used in coffee processing
Unilever	Achieve zero net deforestation associated with palm oil, soy, paper and board, and beef no later than 2020, which also extends to its tea businesses and supply chains
Walmart	Establish agricultural partnerships with 17 suppliers, cooperatives and service providers on 23 million acres in the U.S. and Canada, with the potential to reduce 11 MMT of GHGs, and achieve zero net deforestation in product sourcing by 2020
The Wittern Group	Eliminate deforestation from the production of agricultural commodities by 2020

Regional Baseline Estimates of Carbon Stocks to Inform Land Management Decisions

In an effort to integrate carbon management into decision-making, U.S. government agencies have conducted analyses of baseline carbon stocks on lands under their jurisdiction. This is a first step towards understanding current carbon stocks, changing trends of these stocks, and how these stocks may change with alternative land management strategies. The USFS, DOI, and DOD together manage over 628 million acres in the United States. While these lands are managed for a number of objectives which differ among agencies, increased knowledge and estimates of how carbon changes with management actions will be key to informing land management decisions.

The USFS has developed nine regional carbon assessment reports to help forest managers and the public understand how much carbon is stored in forest ecosystems and harvested wood products. This is provided as a nationally consistent data set and the methodology is consistent with the *Inventory* and UNFCCC requirements. The baseline forest carbon reports provide information from the FIA data on carbon stocks and trends for seven different forest ecosystem carbon pools for the baseline period 1990 to 2013. These reports also provide estimates of carbon stored in harvested wood products.

Within DOI, the USGS has conducted a national assessment of carbon stocks and fluxes for all major terrestrial and aquatic ecosystems from a baseline period of 1992-2005 through projected conditions in 2050. The LandCarbon Atlas online tool currently provides assessment results for the conterminous U.S., while the assessment for Alaska and Hawaii will be finalized in 2016. This national assessment uses data from a variety of sources including the USDA resource inventories, in addition to Landsat satellite data. The USGS is working with the USFWS to understand the effects of specific land management activities on carbon stocks in National Wildlife Refuges, and to quantify carbon sequestration along with other ecosystem services provided by Refuges, such as wildfire risk mitigation, water quality, and biodiversity. The USGS has also completed a study on sequestration in the Greater Yellowstone Ecosystem and worked with the National Park Service to assess the capacity of parks and other protected areas as carbon sinks.

The USGS is currently building on the LandCarbon Atlas to develop an online carbon sequestration decision support tool that may be used by DOI land managers to evaluate land use and management options that affect ecosystem services related to carbon stocks and sequestration.

The USACE has developed and piloted a method to estimate existing carbon sequestration and sequestration potentials on more than 20 million acres of land. In 2015, USACE will apply this method nationally to the most important projects in each USACE district. Lessons learned will identify how and where modernization is required to support carbon management. A second phase to this work will include geographically specific information to help refine the initial estimates of carbon stocks and transfers, including new USACE property boundaries and site-level data supporting the assessment.

Chapter 4. Progress Achieved on the *Priority Agenda for Enhancing the Climate Resilience of America's Natural Resources*

In November 2013, President Obama issued Executive Order 13653 *Preparing the United States for the Impacts of Climate Change*, which called on U.S. government agencies to work with states, tribes, and local governments to improve preparedness for the impacts of a changing climate (EOP 2013b). The Executive Order established an interagency Council on Climate Preparedness and Resilience, which convened a Climate and Natural Resources Working Group (CNRWG) to complete an inventory and assessment of land and water-related policies necessary to make the nation's natural resources and the communities that depend on them more resilient in the face of a changing climate. Agencies were directed to focus on program and policy adjustments that promote the dual goals of greater climate resilience and carbon sequestration.

After the finalization of the CNRWG inventory in October 2014, the Obama Administration issued the *Priority Agenda: Enhancing the Climate Resilience of America's Natural Resources* (EOP 2014). The *Priority Agenda* seeks to improve the management of our natural resources in the context of a changing climate and support investment in natural and green infrastructure. It represents a first of its kind, comprehensive commitment across the U.S. government to support resilience of our natural resources through over 80 concrete actions.

This Chapter highlights agency progress in fulfilling these commitments, including supporting ecosystem resilience through issuing ecosystem services guidance and promoting natural and green infrastructure. Agencies have also worked to assist communities in adapting to climate change through tools and funding around climate risks such as sea level rise, drought, and wildfire. Finally, there are many examples of agencies modernizing federal programs to incorporate climate change considerations, including natural resources planning and management, land acquisition, and natural resource financial assistance programs.

This Chapter is organized by three of the four *Priority Agenda's* thematic areas: [6]

1. Foster Climate-Resilient Lands and Waters
2. Enhance Community Preparedness and Resilience by Utilizing and Sustaining Natural Resources
3. Modernize Federal Programs, Investments, and Delivery of Services to Build Resilience

Foster Climate-Resilient Lands and Waters

The Obama Administration is fostering climate resilient lands and waters through numerous multi-agency programs and initiatives.

Building Resilience through Ecosystem and Landscape Conservation Priorities

In April and June 2015, several U.S. government agencies, in partnership with state, local, and tribal stakeholders, announced the *Resilient Lands and Water Initiative* and its seven flagship geographic locations where targeted conservation and restoration activities will be used to build climate resilience in vulnerable regions, enhance carbon storage capacity, and support resource management needs. These areas are in the Puget Sound, Great Lakes, Southwest Florida, Hawaii, California (2), and the northern Rocky Mountains. Federal agencies and their partners in each area are conducting analysis and developing products to better understand climate-related risks and vulnerabilities to that ecosystem and

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[6] The fourth *Priority Agenda* thematic area, *Manage and Enhance U.S. Carbon Sinks*, has been incorporated into Chapter 3 of this Progress Report.

also implementing projects to reduce those risks; products being developed and actions being taken include coastal wetlands and invasive species mapping, climate scenarios and vulnerability assessments, and ecosystem restoration projects. By October 2016, agencies and their partners will identify and map priority areas for conservation within each of the flagship landscapes. Over the next year, agencies will report progress quarterly on building resilience in the selected areas.

In October 2015, the White House Council on Environmental Quality convened a workshop toward developing, by early 2016, a Federal Framework for Ecosystem Resilience that would integrate ongoing ecosystem resilience index initiatives. These initiatives include the interagency Community Climate and Hazard Resilience Indicators initiative led by the Federal Emergency Management Agency (FEMA) and NOAA, DOI's Metrics Expert Group, the Coastal Green Infrastructure and Ecosystem Services Task Force, and the Systems Approach to Geomorphic Engineering Community of Practice. The Council will convene a follow up federal workshop on December 4 to refine the Framework and plan an online ecosystem resilience indicators tool.

Fight the Introduction and Spread of Invasive Species

In 2015, U.S. government agencies including DOI, Department of Commerce/NOAA, EPA and USDA, in conjunction with the National Invasive Species Council, states, and tribes, are finalizing a framework for the first national Early Detection and Rapid Response program. Early detection and rapid response —a coordinated set of actions to find and eradicate potential invasive species before they spread and cause harm—can help stop the next lionfish, the next cheatgrass, or the next Asian carp. This invasive species framework will help states and tribes forestall the stress caused by the establishment and spread of additional invasive species populations, thereby improving the resilience of priority landscapes and aquatic areas.

Foster Resilience in the Arctic, U.S. Territories, and Freely Associated States

The Obama Administration has achieved significant progress working with international partners to foster resilience in the Arctic, U.S. Territories, and Freely Associated States. In 2015, the United States assumed the two-year chairmanship of the Arctic Council and President Obama established the Arctic Executive Steering Committee. A number of federal agencies are leading a suite of initiatives to promote community and ecosystem resilience in the Arctic (Table 5).

In November 2015, federal agencies including EPA, DOI, NOAA, USFWS, and USDA joined forces with the governments of Puerto Rico and the U.S. Virgin Islands to host the second annual Climate Change in the Caribbean conference. Participants discussed the progress made to address climate change and the need for further action. At the conference, EPA also signed a Memorandum of Understanding with the governments of Puerto Rico and the U.S. Virgin Islands to share climate change expertise.

In June 2015, DOI's Office of Insular Affairs and the Government of Guam hosted the first ever Insular Areas Climate Change Stakeholder Meeting in Guam. Government officials and stakeholders discussed progress to date in developing climate change adaptation and resiliency plans. The Office of Insular Areas is working to integrate climate change adaptation and resiliency priorities in the use of Compact funds for the Federated States of Micronesia and the Republic of the Marshall Islands. In September 2015, the United States and the Republic of the Marshall Islands agreed that the Republic of the Marshall Islands will use its Compact Funds of $52.3 million in 2016 to prioritize or implement climate change adaptation policies, plans, assessments, and projects. The Office of Insular Affairs awarded several grants in 2015, which are detailed in Box 3.

Table 5. Initiatives to foster community and ecosystem resilience in Alaska and the Arctic.

Arctic Resilience Initiatives		Leading Partners
Arctic Council	❖ Formed an expert group on Arctic invasive species to develop a circumpolar plan expected in 2017 for preventing and managing invasive species	DOI/ National Invasive Species Council/ State
	❖ Expanding an Arctic community-based observation network for communities to report anomalous environmental events	EPA
	❖ Expanding the use of an interdisciplinary tool, One Health, to increase the resilience of Arctic communities and ecosystems	State
Arctic Executive Steering Committee	❖ Installed two new U.S. Climate Reference Network Stations in Alaska this summer, bringing the total network to 18 out of 29 planned stations.	NOAA
	❖ Launch the first of three sampling cruises in 2015 to gather Arctic marine-biodiversity data ❖ Second and third cruises planned for 2016 and 2017)	Arctic Marine Biodiversity Network
	❖ Coordination of Federal, State and Tribal resources to assist communities in addressing the impacts of climate change, including coastal erosion, flooding, and permafrost degradation ❖ Commitment of $2 million to support voluntary relocation efforts and other resilience strategies for vulnerable rural Alaskan communities	The Denali Commission
	❖ Revising definitions and eligibility of the Rural Alaska Villages Grant Program to improve water system conditions ❖ Provided $15.9 million in new grants for 17 projects to ensure safe, reliable drinking water and waste-disposal systems.	USDA
	❖ Consultation on pilot guidance for tribes to request Stafford Act declarations	FEMA
	❖ Expanded the Climate Data Initiative to include a new "Arctic" theme that encompasses more than 250 Arctic-related datasets, more than 40 maps, tools, and other resources designed to support climate-resilience efforts in Alaska and the Arctic	NOAA/NASA/DOI

Box 3: U.S. Insular Area Grants

❖ $150,000 to the Micronesia Conservation Trust (Federated States of Micronesia) to conduct a vulnerability assessment on Pohnpei's 5,500 hectares of mangrove forest; assess the feasibility of funding habitat conservation by marketing carbon credits; and share project results to catalyze similar projects throughout Micronesia

❖ $335,156 to the University of Guam to focus research, policy-making and action on the dire conditions of the region due to climate change

❖ $300,000 to the American Samoa Government to implement climate change research and habitat restoration that directly support conservation of native flora and fauna on Tutuila and Ta'u Islands, the two largest-forested Islands of American Samoa

❖ $50,000 to the Boys and Girls Club of American Samoa to create a climate change program for youth focused on promoting public awareness, education, and advocacy

Enhance Community Preparedness and Resilience by Utilizing and Sustaining Natural Resources

The *Priority Agenda* calls for the U.S. government to enhance community preparedness and resilience through programs and policies that also sustain our natural resources (EOP 2014). Agencies have made substantial progress incorporating these goals into federal decision-making, expanding collaboration with communities, and strengthening the ability of our natural resources and communities to adapt and respond to the challenges of climate change. In addition, to recognize community leaders and others working to enhance collaboration and innovation of climate resilience, the *Priority Agenda* spurred the creation of the Climate Adaptation Leadership Award for Natural Resources, a collaborative effort between the National Fish, Wildlife, and Plants Climate Adaptation Strategy's Joint Implementation Group including federal agencies (DOI, NOAA, EPA, NRCS, and USFS) and State fish and wildlife agencies. In November 2015, the first call for nominations was released; final Award-winners are expected to be announced in early 2016.

Incorporating Ecosystem Services into Federal Decision-Making

In October 2015, the Administration issued policy guidance that provides broad direction to federal agencies to integrate consideration of ecosystem services in programs, policies, and regulatory analyses. Within six months, agencies will develop descriptions of current practice and work plans that identify priority policies or programs targeted for incorporation of these approaches, which will be further refined upon release of the final implementation guidance.

As one example, in 2013, FEMA's Federal Insurance and Mitigation Administration issued a policy promoting the consideration of ecosystem services in benefit cost analysis for acquisition for open space projects funded under *Hazard Mitigation Assistance* programs. FEMA is currently building upon that policy to:

- ❖ Apply ecosystem service valuation to other *Hazard Mitigation Assistance* programs related to drought, wildfire, and flood

- ❖ Consider sea level rise for mitigation project development and include expected risks in the benefit cost analysis

- ❖ Develop efficiencies for pre-calculated benefits for ecosystem services for flood acquisitions, wind retrofits, and certain wildfire projects to facilitate expedient evaluation of project cost effectiveness

Strengthening Community Collaboration and Natural Resources Protection

Several agencies have been expanding collaboration and technical assistance by helping communities implement green infrastructure and enhancing natural resources protection in coastal communities (EOP 2014).

In 2015, EPA continued work with other Federal agencies to advance the Green Infrastructure Collaborative to help communities manage storm water and rapidly adopt low impact development techniques. In October 2015, EPA conducted a Green Infrastructure Learning Lab for 80 invited communities, where Green Infrastructure Collaborative members and federal agencies provided hands-on training to help community participants identify the best approaches for integrating resilient and sustainable practices at the community level. EPA is also working with USDA's Rural Utilities Service to develop guidance to increase the use of green infrastructure.

In September 2015, FEMA, Federal Insurance and Mitigation Administration announced three new Climate Resilient Mitigation Activities eligible for Hazard Mitigation Assistance funding beginning in FY16.

The activities are Aquifer Storage and Recovery, Flood Diversion and Storage, and Floodplain and Stream Restoration. These activities promote green infrastructure methods to encourage sustainable water resource management, increase water supply and water quality for drought mitigation, and to reduce or manage risk from flood and erosion.

EPA recently published a new green infrastructure web-based planning tool, called GIWiz, offering green infrastructure tools and resources designed to support and promote sustainable water management and community planning decisions. These tools and resources help users analyze problems, understand management options, calculate design parameters, analyze costs and benefits, evaluate tradeoffs, engage stakeholders, and/or develop education and outreach campaigns.

In September, 2015, EPA's Office of Water announced the 4th annual Campus RainWorks Challenge for undergraduate and graduate students. EPA is inviting student teams to design an innovative green infrastructure project for a location on their campus. Winning teams will be awarded a student prize as well as a faculty prize to support green infrastructure research or training.

In 2015, NOAA created an online *Green Infrastructure Mapping Guide* that shows spatial analysts how to incorporate green infrastructure as a coastal resilience strategy (NOAA 2015a). NOAA also released a *Guide for Assessing Green Infrastructure Costs and Benefits for Flood Reduction*, which is based on green infrastructure technical assistance work with Great Lakes communities (NOAA 2015b). The Guide provides a six-step approach to documenting the costs of flooding, projecting increased flooding and associated costs under future land use and climate conditions, and calculating benefits and costs of reducing flooding with green infrastructure. As a companion to the Guide, the *Green Infrastructure Options to Reduce Flooding* quick reference highlights green infrastructure benefits, limitations, and tips on estimating floodwater storage potential and costs (NOAA 2015c). Additionally, NOAA created *Guidance for Considering the Use of Living Shorelines*, which emphasizes how living shorelines can preserve and improve habitats and their ecosystem services at the land-water interface (NOAA 2015d). The guidance describes NOAA's living shorelines guiding principles and its role in providing science, tools, and training to help inform community selection of appropriate natural infrastructure techniques.

As part of its work on coastal resilience, NOAA delivered new tools in 2015to better understand, prepare for and respond to climate-related impacts on the nation's valuable marine and coastal fish stocks and people that depend on them. As part of this toolkit, the agency plans to complete the first major assessment of climate vulnerability in major commercial and recreational fish stocks across the U.S., including the Northeast, the West Coast, and the Bering Sea. In the Northeast region, this will include an assessment of climate vulnerability for 82 species of marine fish and shellfish. In 2015, NOAA also launched a major new project to provide fisheries managers with strategies to help reduce climate change impacts and increase resilience of fish stocks and fisheries in the Bering Sea region. NOAA will also update the OCEANADAPT marine species distribution tracker with new information to help resource managers and users assess and track changes in the distribution of over 650 species involved in U.S. commercial and recreational fishing.

Furthermore, NOAA has built several tools and has committed over $85 million in grants (Table 6) that will help inform and support decision makers, advance understanding of the Earth's climate system, and strengthen the resilience of coastal resources and communities. Table 7 provides examples of tools and awards provided by U.S. government agencies to support coastal and community resilience.

Table 6. NOAA coastal awards.

NOAA Coastal Awards		
Grants	**Purpose**	**Grant Amount**
Sea Grant	Help build resilient coastal communities and economies	$24 million to support over 300 projects
Regional Coastal Resilience Grant program & Coastal Ecosystem Resiliency Grant program	Support regional approaches to build resilience to negative impacts from extreme weather events, climate hazards, and changing ocean conditions	$9 million ($5 million for regional coastal resilience awards; $4 million for coastal ecosystem resiliency awards)
National Centers for Ocean and Coastal Science	Research on the combined effects of ocean acidification, increased nutrient pollution and low oxygen levels on economically and ecologically important marine species and coastal habitats	More than $1.3 million to three universities
Climate Program Office	Research projects to increase understanding and preparedness for climate impacts on marine fish stocks and fisheries in the US Northeast region	$2.9 million
Climate Program Office	Advance the understanding, modeling, and prediction of Earth's climate system, the impacts associated with climate extremes, and risk management strategies to contribute to effective decision making.	Multi-year awards of $48 million to 53 new projects

Table 7. Tools that support coastal and community resilience.

Coastal and Community Resilience Initiatives			
Tool	**Data Included**	**Application**	**Agency**
Marine Ecosystem Dashboard	Past, current & future climate and marine ecosystem conditions in the Northeast	Provides federal, tribal, state marine resource managers and communities with information for planning	NOAA
Coastal Flood Exposure Mapper	Maps of coastal states on the East Coast and Gulf of Mexico showing people, places, and natural resources exposed to coastal flooding	Helps communities assess their coastal hazard risks and vulnerabilities	NOAA
Climate Change Vulnerability Assessment Tool for Coastal Habitats	Integrates local data and knowledge with climate change research, predictions, and assessment	A decision support tool to provide an evaluation of habitat vulnerability on the east coast	NOAA
Integrated Marine Protected Area Climate Tools	Information for the Florida Keys National Marine Sanctuary	Management, adaptation and planning	NOAA
Climate Ready Estuaries Program Climate Change Workbook	Organizes and links to diverse data sources related to estuary management and climate change	Workbook to support estuary managers in assessing climate change vulnerability and design of adaptation plans	EPA

Promote Community Resilience to Natural Hazards and Droughts

A main objective in the *Priority Agenda* is to partner with communities to enhance resilience to natural hazards risks and expand partnerships to reduce wildfire risk and protect community infrastructure (EOP 2014). In 2014, the Wildland Fire Leadership Council launched the *National Cohesive Wildland Fire Management Strategy*, which focuses on fire adapted communities, response to wildland fire, and restoring and maintaining landscapes (DOI and USDA 2014). The *Strategy* is being implemented through various multi-agency efforts.

USDA is heading the $30 million Two Chiefs Joint Landscape Restoration Partnership between the USFS and NRCS with a goal of improving the health and resilience of forest ecosystems where public and private lands meet. Similarly, DOI announced a $10 million Fire Resilient Landscapes Program that promotes integration and coordination among DOI's four wildland fire management bureaus and their natural resource counterparts, as well as landscape-scale activities in partnership with other Federal, tribal, state, and local government and non-governmental partners. Recently, DOI released the *Integrated Rangeland Fire Management Strategy* to coordinate this landscape fire management effort.

As part of the *National Cohesive Wildland Fire Management Strategy*, agencies are coordinating programs for hazardous fuels reduction (DOI and USDA 2014). DOI is also issuing community assistance agreements with tribal, state, and local government, and individual landowners to help manage wildfire risk. DOI and USDA are engaging with local municipalities and towns to reduce hazardous fuels in critical watersheds through the Western Watershed Enhancement Partnership. The Collaborative Forest Landscape Restoration Program has treated more than 1.45 million acres of hazardous fuels since 2010.

The *Priority Agenda* also stresses the importance of promoting drought resilience and enhancing water use efficiency, water reuse, and water supply (EOP 2014). The interagency Water Resources and Climate Change Adaptation Workgroup is currently creating a draft charter for a federal agency support team to work with states on issues of common concern around water resources management, modeled after the successful WestFAST partnership among Federal agencies, States, and Tribes in the west. The Workgroup is also engaging stakeholders as part of a project to revise and update the 2011 *National Action Plan: Priorities for Managing Freshwater Resources in a Changing Climate.*

In addition, the National Drought Resilience Partnership (NDRP), an interagency partnership launched by the *Climate Action Plan* in 2013, is working to ensure the long-term interagency coordination needed to drive effective drought response, recovery, and resilience at all levels. This includes promoting agency actions around improving water data and information, supporting regional drought planning, coordinating federal investments, and market based approaches. This Partnership, together with the National Integrated Drought Information System, is continuing to leverage Federal collaborations with communities, businesses, farmers, and ranchers to build long term drought resilience and help prepare for future drought events (EOP 2013a). In June 2015, with the help of NDRP agencies, the President convened the Western Governors and senior Administration officials for an update on the Federal Government's activities in support of drought-afflicted states. In July 2015, the Partnership hosted a White House Drought Symposium, bringing together a small group of high-level experts on water and drought issues across government, academia, the agricultural sector, conservation organizations, and others in the private sector to explore opportunities to improve long term sustainability of water resources through improved coordination, collaboration, and management.

In September 2015, more than 80 participants representing state and federal agencies, conservation districts, municipalities, non-governmental organizations, local watershed groups, and other interested parties met to discuss the NDRP's Montana Drought Demonstration Project. Watershed groups presented information on their drought-related activities, challenges, and opportunities. The meeting initiated the

project, which finalized its work plan at the end of October 2015. Box 4 provides more detail on U.S. government assistance for drought response.

Box 4: Federal Assistance for Drought Response and Resilience

❖ **Federal Emergency Management Agency's Federal Insurance and Mitigation Administration:** On September 30, 2105, FEMA, Federal Insurance and Mitigation Administration announced three new Climate Resilient Mitigation Activities eligible for Pre-Disaster Mitigation program and Hazard Mitigation Grant Program (post disaster) funding. The activities are Aquifer Storage and Recovery, Flood Diversion and Storage, and Floodplain and Stream Restoration. These activities promote green infrastructure methods to encourage sustainable water resource management, increase water supply and water quality for drought mitigation, and to reduce or manage risk from flood and erosion.

❖ **The WaterSMART Water and Energy Efficiency and Title XVI Grants**: In May 2015, DOI announced $50 million in grants to improve water efficiency and conservation in Western states.

❖ **NRCS Environmental Quality Incentives Program funding**: In May 2015, USDA announced the availability of an additional $21 million through the program, targeted to farmers and ranchers in eight western states experiencing extreme or exceptional drought as defined by the U.S. Drought Monitor. $13.7 of the $21 million was made available to California producers for practices improving rangeland health and improving water use efficiency.

❖ **New Drought Response Program:** In August 2015, the Bureau of Reclamation announced 23 projects to receive $5.2 million in grants that provide cost-share funding for proactive drought planning and projects to build long-term drought resiliency in state, tribal, and local governments in 17 Western States.

❖ **USDA and NASA Innovative Partnership**: This expanded partnership is designed to better protect America's working lands, predict and prevent natural disasters, and inspire young people to pursue careers in science, technology, engineering, mathematics and agriculture. Under the new agreement, NASA satellite data is helping USFS firefighters and first responders better detect wildfires and predict fire behavior. Additionally, the agencies plan to use the satellite data with on-site soil moisture data to create soil moisture maps to improve forecasting and provide a drought early-warning system for producers.

❖ **USDA Regional Conservation Partnership Program:** In January 2015, the agency announced more than $370 million in funding to 115 high-impact conservation projects across the nation to improve soil health, water quality and water use efficiency, wildlife habitat, and other related natural resources on private lands. Roughly $60 million was dedicated to projects that primarily target water quantity or drought-related resource concerns. In May 2015, up to $235 million was announced for the next round of projects.

❖ **Drought Risk Management Research Center:** In June 2015, NOAA's National Integrated Drought Information System, in partnership with the agency's Sectoral Applications Research Program, announced the creation of the Drought Risk Management Research Center at the National Drought Mitigation Center at the University of Nebraska- Lincoln.

❖ **California Headwaters Partnership:** USDA is leveraging investments with California and DOI to knit together over $210 million in forest restoration and headwater protection efforts in the Sierra-Cascade headwater region, which provide drinking water to 25 million people. The California Headwaters Partnership is taking a watershed and landscape-level approach to restoration and is one of the Priority Agenda's Resilient Land and Water's locations.

Modernize U.S. Government Programs, Investments, and Delivery of Services to Build Resilience

Many U.S. government programs have already made efforts to update existing operations to promote resilience and carbon sequestration considerations. Agencies have built on this momentum through innovative actions, including revisions to natural resources management plans, bolstering financial assistance programs, and creating new training programs and information services.

Enhance Resilience through Natural Resources Planning and Management

According to the directive in the *Priority Agenda*, agencies including DOD, DOI, EPA, NOAA, and USDA are working to incorporate resilience into natural resources planning and management (EOP 2014). Some of these programs have been mentioned previously in this Progress Report, such as resilience-building through the USDA Climate Hubs and the USFS land management planning directives, and are not repeated here.

In addition, The Bureau of Land Management (BLM) is working on consolidating existing habitat restoration funds to enhance protection, conservation, and restoration of native ecosystems to build greater resilience to climate change. A consolidated restoration fund will allow BLM to focus efforts on the highest priority areas and accomplish efficient and effective vegetative management such as implementing National Seed and Pollinator Strategies, implementing conservation measures from the land use plan amendments for the Greater Sage Grouse, and implementing the DOI's Integrated Rangeland Fire Management Strategy.

EPA national programs and ten Regional Offices released *Climate Change Adaptation Implementation Plans*, which each describe priority actions to strengthen adaptive capacity, including actions to support vulnerable populations. Some key actions include:

❖ Updating Architecture and Engineering Guidelines for EPA buildings to address climate change stressors, identify vulnerabilities, and address climate resiliency considerations

❖ Working with coastal states to identify potential steps to build resilience at critical water facilities, including wastewater treatment plants and drinking water plants at risk of major service interruption resulting from storm surges. EPA, NOAA, and FEMA have collaborated to identify and map the wastewater and drinking water plants most at risk in the Gulf of Mexico and Atlantic coasts. EPA has also developed an innovative four-tier risk assessment method that provides an initial indication of the degree of risk faced by facilities in these storm surge zones

❖ Working with the Associations of Clean Water Agencies, State Drinking Water Administrators, and State Wetland Managers to identify and describe practices that state water agencies have implemented to adapt water programs to a changing climate

In August 2015, NOAA released the *Fisheries Climate Science Strategy* as part of a proactive approach to increase the production, delivery, and use of climate-related information needed to fulfill the agency's mission in a changing climate (Link et al. 2015). The *Strategy* identifies seven key objectives to reduce impacts and increase the resilience of marine/coastal fisheries, protected species, and the many communities and economies. In August 2015, NOAA released an agency-wide *Habitat Policy* that outlines a set of guiding principles that will apply to all of its habitat work and will influence future actions and priorities related to habitat conservation. The *Policy* promotes increased place-based conservation, habitat protection, and restoration in a landscape-scale context that includes connective coastal and marine habitats and considers the ecosystem services and economic value of those habitats in decision making.

The Department of Defense is reviewing its internal regulations to identify how climate change could be considered in policies and practices. Several policies have been updated, including a training policy released in September 2015 that establishes DOD procedures to identify, assess and report on the potential impacts of climate change on training capabilities.

The U.S. Army Corps of Engineers is drafting an enterprise-wide, *Resilience Strategy* to guide updates to resilience-related activities to support future needs in the community resilience arena, including the use of natural resources resilience features. This strategy should be completed in 2016. Additionally, the

resilience team drafted a catalog of USACE resilience-related activities, metrics, and tools, and initially identified potential areas to bring USACE activities into better alignment with overall community resilience goals. The USACE will identify demonstration sites to test and exemplify the most effective ways to employ best practices, including enhancing visitation, education, and outreach activities to encourage emulation of these practices more broadly in the public and private sectors.

Address Resilience Needs through Financial Assistance

The *Priority Agenda* calls for the U.S. government to address resilience needs by modernizing land acquisition and natural resource financial assistance programs (EOP 2014).

To meet this challenge, the Department of the Interior has implemented several initiatives. For example, the USFWS is working with states to help them better incorporate climate risks and resilience into projects funded by the State and Tribal Wildlife Grants Program which benefits wildlife and their habitat. Under this program, states and territories must develop a *State Wildlife Action Plan* to be eligible to receive funds. In 2013, the USFWS implemented a new *State Wildlife Action Plan* Enhancement Program to encourage and assist state-level fish and wildlife agencies in incorporating climate change science into their plans. In 2015, 45 state fish-level and wildlife agencies were making progress toward this goal, increasing the likelihood that future investments in these grants will deliver conservation results that are designed with climate risks in mind.

In 2015, DOI's Tribal Climate Resilience Program awarded over $16 million to tribes, including $1.4 million to support internships for tribal youth working on projects or performing research directly related to climate change impacts and $14.6 million to help federally recognized tribes and tribally charted organizations with climate change and ocean and coast management planning projects. Projects will help tribes plan, train and participate in technical workshops and forums, while also supporting coastal tribes as they address the unique challenges of coastal erosion and development, rising sea levels, ocean acidification, and emergency management. NOAA also contributed nearly $300,000 for a project to foster adaptation in Alaska Native coastal communities to maintain or improve their health and vitality over time by anticipating and adapting to change.

EPA has also been working with its partners to make more financial assistance available through its programs. The agency recently released a new National Estuary Program Grant Guidance for addressing climate resilience through enhanced planning. This Guidance calls for recognizing climate change impacts in existing *Comprehensive Conservation and Management Plans* for each of the 29 estuaries in the National Estuary Program. EPA will work with each estuary to revise and approve their management plans.

EPA is also using financial mechanisms to support incorporation of climate change adaptation into environmental program implementation focusing on Clean Water and Safe Drinking Water Revolving Loan Funds. EPA's State Revolving Funds are the single largest financial investment that the agency makes in supporting clean water and drinking water projects at the community level. EPA developed a *Conservation Guide* to explain how climate change impacts might be addressed in selecting and implementing projects in a checklist that EPA uses to assess the State Revolving Funds programs. In 2016, EPA will begin tracking the number of clean water and drinking water State Revolving Funds programs that use financial incentives to promote climate resilience.

In the summer of 2015, the National Fish and Wildlife Foundation—a non-profit that supports conservation efforts across the Nation— awarded its third year round of projects through the Five Star and Urban Waters Restoration Grant Program, which is funded by EPA, USFS, USFWS, and corporate supporters. A combined 66 projects totaling $2.3 million were awarded to restore urban waters and

engage thousands of volunteers in community-based environmental stewardship projects. As part of its Urban Waters Federal Partnership Commitment, the USFS is engaged with the partners in supporting community grants for urban watershed revitalization.

Provide Resilience Training and Information Services

An important step toward achieving the goals set out in the *Priority Agenda* is providing climate change and resilience training to resource managers and stakeholders. Several U.S. government agencies have created innovative information services and data platforms to facilitate training goals, as well as create user-friendly interfaces for the public to learn about the impacts of climate change and resilience-enhancing activities in their communities. Initiatives, such as the USFS web-based Climate Change Resource Center, connect land managers and decision makers with usable science to address climate change in their planning- and project-related work.

NOAA, USDA, EPA and DOI, in coordination with other U.S. government agencies that support regional resilience, are working to improve the U.S. *Climate Resilience Toolkit*. Since 2014, these agencies have provided over 200 science-based decision-support tools and over 90 case studies about people using those tools and taking action to build resilience all across the nation.

The *Climate Resilience Toolkit* Team is incorporating climate projection data into a Climate Explorer tool, which will allow users to visualize the direction and relative magnitude of past, present, and future climate-related changes at relevant scales including local, regional, state, and national. The Team expects to publish version 2.0 of the *Climate Resilience Toolkit's* Climate Explorer in December 2015, featuring easy access to climate projection data at county-scale resolution. Furthermore, the Team has been forming new, interagency regional teams to identify and gather tools, case studies, map layers, and professional development courses appropriate for inclusion in the *Toolkit*.

In May 2015, EPA and its Local Government Advisory Committee released an online training module to help local governments adapt to climate change as part of the *Toolkit*. The training provides municipal officials with information about how climate change may affect the services they manage, such as drinking water and emergency response for droughts, fires and floods. It also provides examples of successful policies and actions that have already been undertaken by local governments, as well as links to resources that can assist in risk assessment and management. In a related project, EPA has developed an online water resources and climate change training module for the National Watershed Academy..

In collaboration with the White House Council on Native American Affairs, agencies expanded the *Climate Resilience Toolkit* to include a new Tribal Nations theme, comprised of more than 40 resources to assist Tribal nations in climate-change planning, adaptation, and mitigation. Resources include a comprehensive *Tribal Climate Change Adaptation Planning Toolkit* and a set of guidelines for considering traditional knowledge in climate change initiatives.

In 2015, DOI and its interagency partners have been developing a framework for education and training to build climate literacy among federal agency staff and technical service providers such as planners, engineers, and consultants. The framework will provide a strategic approach for agencies to implement goal-driven climate training and educations programs and to collaborate to leverage new and existing efforts. This *Framework for Building Climate Literacy and Capacity among the Workforce of Federal Natural Resource Agencies* is planned for release in late 2015.

Prepare Indigenous Communities for the Impacts of Climate Change

The Priority Agenda focuses on creating climate resilience-enhancing programs to meet the specific needs of tribal communities. In addition to these initiatives, agencies are also working to provide funding and information-specific tools for Native Americans to prepare and adapt to climate change, as detailed in other sections of this report.

The USFS has charted a path for assisting tribal communities to prepare for and recover from the impacts of climate change. Each USFS Region is developing at least one tribal flagship partnership, with eight partnerships already underway.

❖ *The Western Klamath Restoration Partnership*, comprised of the Karuk Tribe, USFS, the Mid Klamath Watershed Council, the Salmon River Restoration Council, and Fire Safe Councils, is instituting collaborative fire management that incorporates traditional tribal land practices and stewardship and that mentors and educates the next generation of conservation stewards.

❖ *USFS Northern Institute of Applied Climate Science Programs* is working with numerous Tribal Adaptation Partnerships throughout the upper Midwest and Great Lakes regions to design adaptation actions for tribal lands that work to achieve their goals and reflect tribal values.

❖ Scientists are working with youth from Alaska to the Southeast to assess the vulnerability of subsistence foods to the impacts of climate change, and are beginning to explore the effects of extreme climate events and glacier-melt on Indian sacred sites and trust assets.

The Tribal Youth Climate Leadership Congress was held in July 2015 by USFWS, Bureau of Indian Affairs, National Park Service, USGS, and the USFS to promote youth engagement and positive community action for climate resilience for 89 native youth from around the country, including Alaska and Hawaii.

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