INNOVATIVE RESEARCH - WHY PRECISION FORESTRY?

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RESEARCH –WHAT AND WHY?

- **WHAT?**
  - A way of looking for new information, new understanding and new facts for the purpose of solving problems and increasing available knowledge

- **WHY?**
  - **One major obligation** (For Research Institutes, Universities, Industries, Government)
  - **For Promotion and Growth** (A measure of individual and Corporate success)
  - **For Development** (Human capacity, Industrial, Regional, Sub regionals)

BASIS FOR INOVATION NOW

- Creating more effective processes and products. (forestry slower to catch on)
  - **Implement new ideas to create jobs, reduce poverty and food insecurity** (research must centre on value chain addition in the forestry sector)
  - **Improve services** (quality of research must strive toward global standard, may require tinkering with existing training and production benchmarks; and legality should be promoted)
  - **Create dynamic products** (changing Forest, changing climate and changing economies)
  - **Adapt in the market place** (forestry is now data science and digital technology driven)
  - Adopt sectoral measures on health and safety (in line with established protocols)

What is Precision Forestry?

"Precision forestry" (PF) is a term used for

- Data science and;
- Digital technologies in forestry.

Scope of Precision Forestry:

- Building models of soil, ecosystem and tree health
- Monitoring forest health through Remote sensing (RS) data
- Developing machines, sensors and algorithms for tree/timber harvesting
- Flying drones to identify forest fires
- Better breeding programs through genetics

GLOBAL STATUS OF PRECISION FORESTRY

- Forests have a huge impact on climate, ecosystem services and on livelihoods of communities that rely on them.

- Forest products (timber, pulp, herbs and others) contribute at least half a trillion dollars to the global economy each year.

- Precision forestry market was estimated at close to $4 billion in 2019

- PF forecast to grow to $6 billion by 2024 at an annual growth of 9%

(Ecoformatics, 2020)

GLOBAL STATUS OF PRECISION FORESTRY CONT.

- Many located in ***Europe*** are focused on timber harvesting, monitoring carbon emmissions and forest health, building climate and carbon trade models (Timbeter, Dendra system, Satelligence, Tesselo, Terramonitor)

- Weyerhaeuser (***US***) and Scion (***New Zealand***) are hiring and building data science teams for agroforestry applications

- Google and Microsoft (***US***) are using cloud computing, RS datasets, and partnerships around the world to develop interesting applications of AI-based forestry for public good.

- ***Asia and Africa*** are expected to be major drivers over the next couple of decades as countries in the region adopt and develop novel technologies and practices.

PROMISING PRACTICES IN PF'S TECHNOLOGICAL LANDSCAPE

- Genetics and nurseries
  - Advanced genetic improvement (genetic profiles suited to site and end use)
  - Automated nurseries (enclosed, controlled environment for raising seedlings)

- Silviculture and Forest Management
  - Site-specific management (fertilization and drainage based on data from soil sensors)
  - Mechanized silviculture(increased use of machine to improve safety, productivity –fertilization and weed control)
  - Fire monitoring (digital monitoring of fires with UAVs or satellite to provide early warnings and coordinate fire fighting)
  - Pest and disease monitoring (digital monitoring of potential outbreaks and coordinate responses to minimize damage)

PROMISING PRACTICES CONT.

- Harvesting and wood delivery
  - Digital inventory (using aerial remote sensing and in-forest devices)
  - Mechanized harvesting (to improve safety, productivity and process control)
  - Remote/automatic loading (loading cranes operated remotely)
  - Wood logistic optimization (software to control dispatch of trucks)
- Across full value chain
  - Forestry planning models (software to support management decisions)
  - Field support tools (mobile devices to give access to forest information)
  - E-dashboards (to visualize performance data based on central electronic data repository)
  - Advanced Analytics (analysis of data to solve complex problems like identifying constraints on tree growth and determine intervention)

McKinsey and Company (2018)

DATA SCIENCE LANDSCAPE

An interdisciplinary field using statistics, computer science and machine learning algorithms to gain insight from structured and unstructured data.

❖TASKS OF A TYPICAL DATA SCIENTIST

- ❑ Data capture through hardware (sensors, robots), apps or websites
- ❑ Data storage and processing, including data cleaning
- ❑ Modelling and analysis - (crop yield, watershed modelling for example, machine learning and statistics)
- ❑ Data visualization - graphic representation of data to detect trend, pattern and outliers)

SKILLS REQUIRED

❖ Knowledge of a Programming Language

POPULAR CHOICES INCLUDE:

- **Python** – Easy to learn computer language with large stark of libraries (for building predictive models using machine learning, processing satellite images)

- **R**- Useful for statistical analysis, initial exploratory analysis of data and quick visualization

- **Fortran**: Used extensively in existing environmental software. You should *be **able to read and understand the code*** underlying many environmental applications.

POPULAR CHOICES cont.

- **Database Tools –**
  - **PostgreSQL-**
    - most popular open source data base system for structured data (data that can be divided into distinct columns that are always the same).
    - Example: data from an air pollution sensor – it could have a latitude, longitude and pollutant concentration value
  - **PostGIS** is an add-on to PostgreSQL
    - for analyzing and dealing with location information in the database as easily as possible.
  - **NoSQL (eg. MongoDB)**
    - For storing unstructured data. This includes things like web page information, social media data from Facebook posts and Tweets etc.

POPULAR CHOICES cont.

- **GIS (***ArcGIS, Erdas Imagine)*
  - to visualize and integrate different data sources **.**
  - The open source alternative is QGIS (allows for integration with Python).
- **Google (Google map and Google Earth)**
  - powerful tools to present data in an interactive format.
  - most useful tools to obtain satellite data.
  - free, accessible and reliable
- **Tensor Flow, PyTorch and other machine learning libraries**:
  - allow data scientists to build deep learning algorithms relatively easily.
- **Hadoop, MapReduce and Pig**
  - for handling big data (Google and Facebook type of data)

CONCLUSION

- Precision Forestry is expected to grow rapidly over the next decades
- Keep research focus on happenings in the young and vibrant PF space.
- Get familiar with data science, satellite imagery access and digital technologies
- Catch up on Google Earth Engine and Microsoft AI for earth initiatives.
- *PYTHON* is key with all its powerful machine learning and data visualization libraries.
- Institutions and Non-profits must Protect and Improve existing **forest data sources**.

TERMS EXPLAINED

- Artificial Intelligence (AI) – Field of computer science that works on computer system to think intelligently and perform tasks like a human (e.g. Voice activated digital assistants, chatbots)

- Machine learning –Algorithm parsing (divide into parts, the step-by-step procedure of solving a problem) and application of AI to manipulate data to gain new insight or improve a model. Looks for patterns and similarities in large data.

- Data visualization – Interdisciplinary field that deals with graphic representation of data. Efficient way of communicating pattern, trends and outliers in groups of large data

TERMS EXPLAINED CONT.

- Cloud computing – delivery of On-demand availability of computer system resources (data storage-cloud) and computing power without direct active management by the user. Data centres are available to users over the internet (e.g. SalesForce for marketing, commerce and services).

- Deep Learning – This is a form of AI that mimics the workings of human brain in processing data for use in detecting objects, recognizing speech, translating languages and making decisions. It can be used to detect fraud and money laundering.

- Internet of Things (IoT) – Internet-able nature of modern physical devices, vehicles and buildings (IoT products)