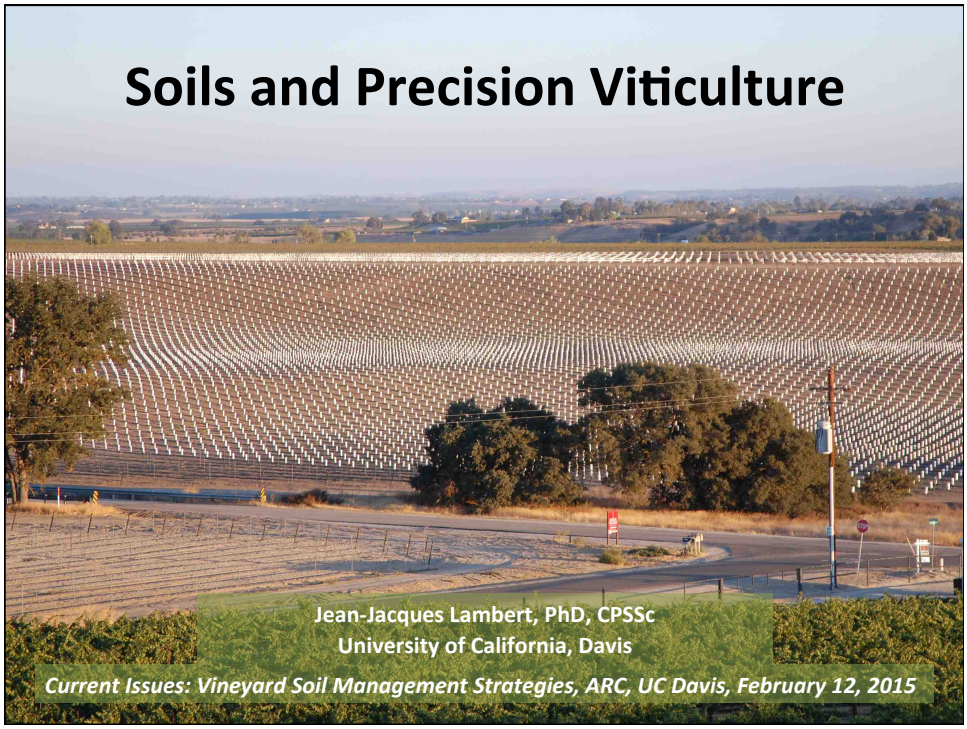


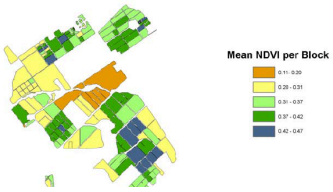
PRECISION VITICULTURE

- PV is an extension of precision agriculture originally developed for field crops in the Midwest
- Use of satellite multispectral imagery (i.e. Johnson-Mondavi, 1996)
- Attempts at selective harvesters, late 90's
- Non degraded GPS data, made available globally (May 2000), drives PV development

GOALS OF PRECISION VITICULTURE

- **Provide the basis for site-specific management**
  - **Soil and topographic surveys**
- **Aid in addressing spatial variability within blocks**
  - **Production variables (vigor, yield...)**
  - **Grape quality variables (brix, acidity...)**
  - **Decision tool (fertility, water status...)**
- **Recording and analysis of information over time**
  - **Soil quality monitoring, crop cover, cultivation records**
  - **Yield and grape quality monitoring**
  - **Fertilization and irrigation history**

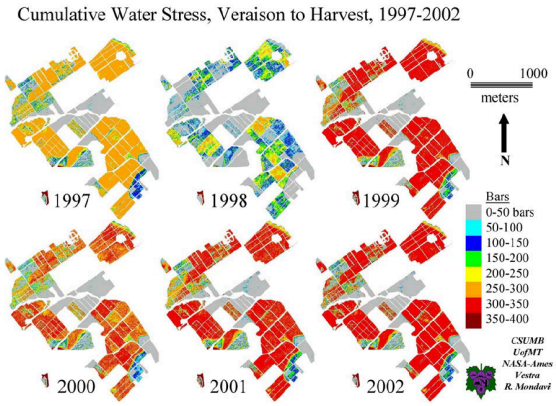
REMOTE SENSING



NDVI: Normalized Difference Vegetation Index :

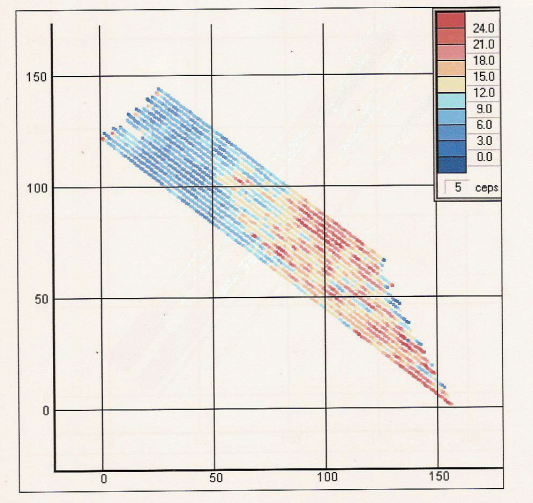
$$\mathrm{NDVI} = \frac{(\mathrm{NIR} - \mathrm{RED})}{(\mathrm{NIR} + \mathrm{RED})}$$

Source: Lee Johnson et al, 2003 ASAE Annual International Meeting, Las Vegas



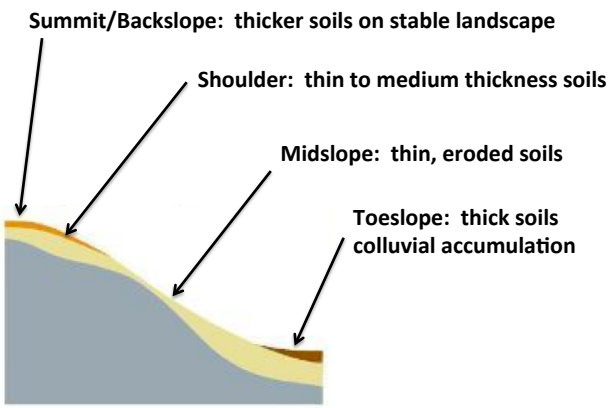
PRE-GPS: LANGUEDOC, FRANCE MAP OF GRAPE YIELD

- Area: 0.6 hectare
- Total weight harvested: 7.6T
- Variation in yield closely related to topography
- Higher elevations: lower yield (~6T/ha)
- Lower elevations: higher yield (~16-18T/ha)



Scale: Yield in T/hectare

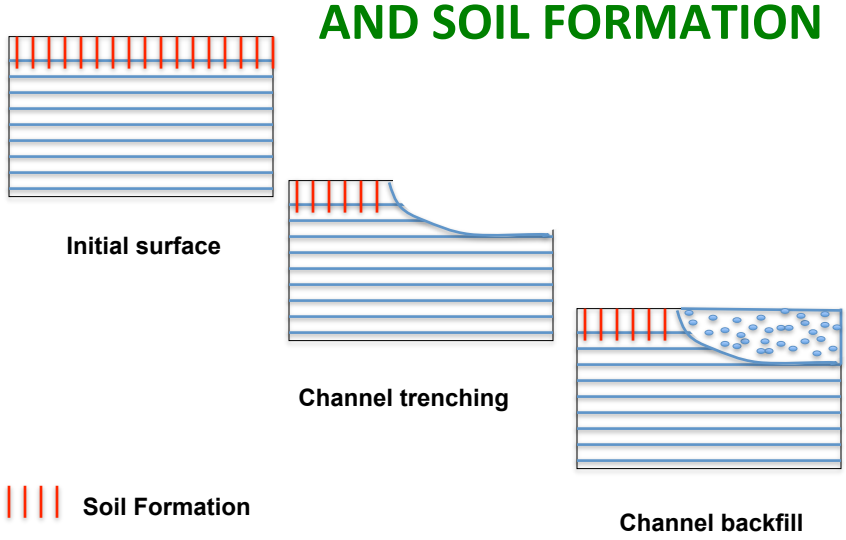
TOPOGRAPHY AND SOIL THICKNESS



SOIL:
THE MAIN SOURCE OF INTRA-BLOCK VARIABILITY

- **The soil on a given site is the product of five factors:**
  - *Climate*
  - *Topography*
  - *Time*
  - *Parent Material*
  - *Biota*

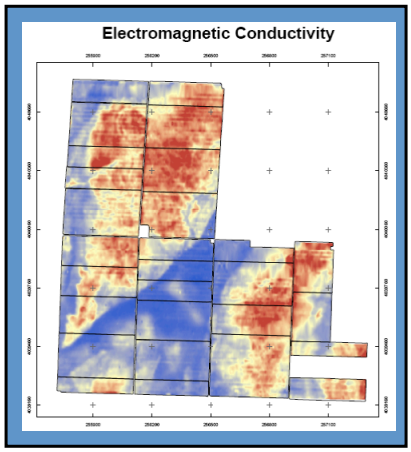
ALLUVIAL EROSION/DEPOSITION AND SOIL FORMATION



Impact of Two Soil Types on Vine Vigor

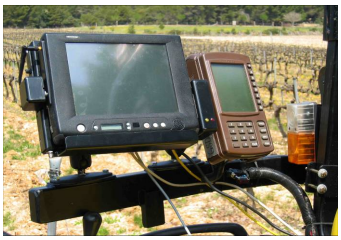
SOIL PROXIMAL SENSING: STEP 1

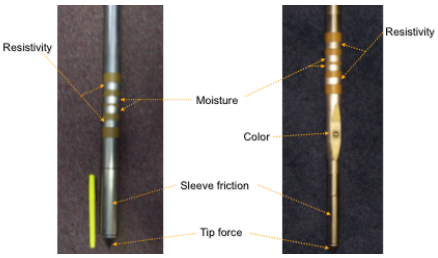
An electrical conductivity map helps to show *where* soil variability is *…but doesn't define it*.



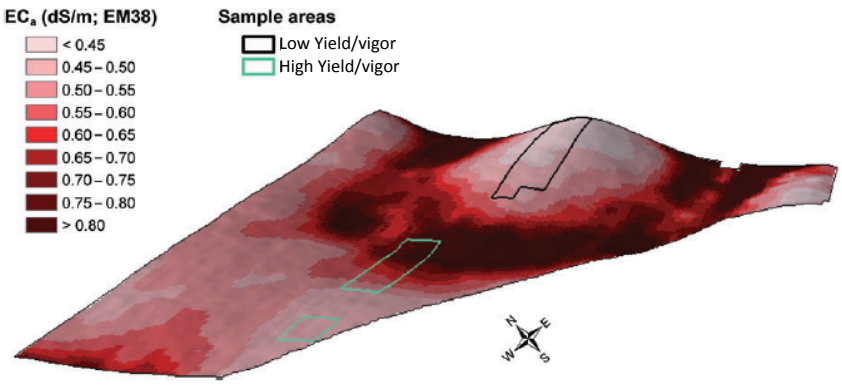
SOIL PROXIMAL SENSING: STEP 2

Use of a modified Geotechnical Probe to derive soil characteristics



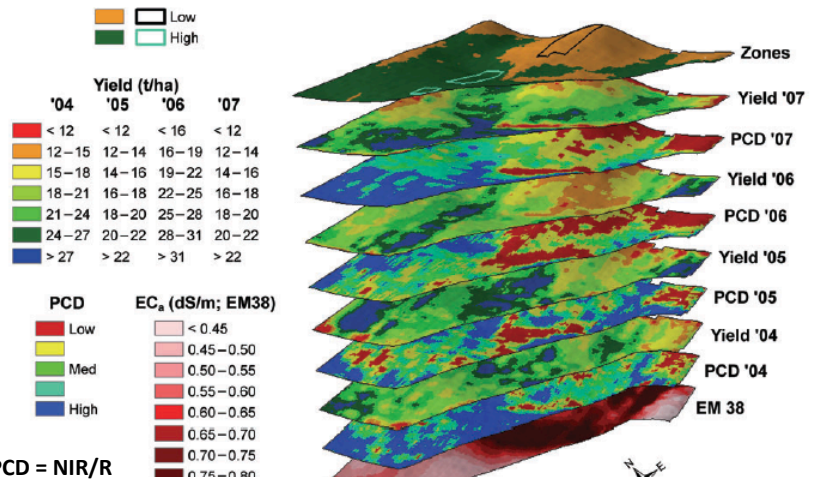


ELECTRICAL CONDUCTIVITY MAP



Source: Bramley et al., 2011
Aust. Journal of Grape and Wine Research
17, 217-229.

ELECTRICAL CONDUCTIVITY (ECa), PLANT CELL DENSITY (PCD) AND YIELD OVER TIME



PCD = NIR/R
Ratio of reflected Infrared over red

Bramley et al., 2011

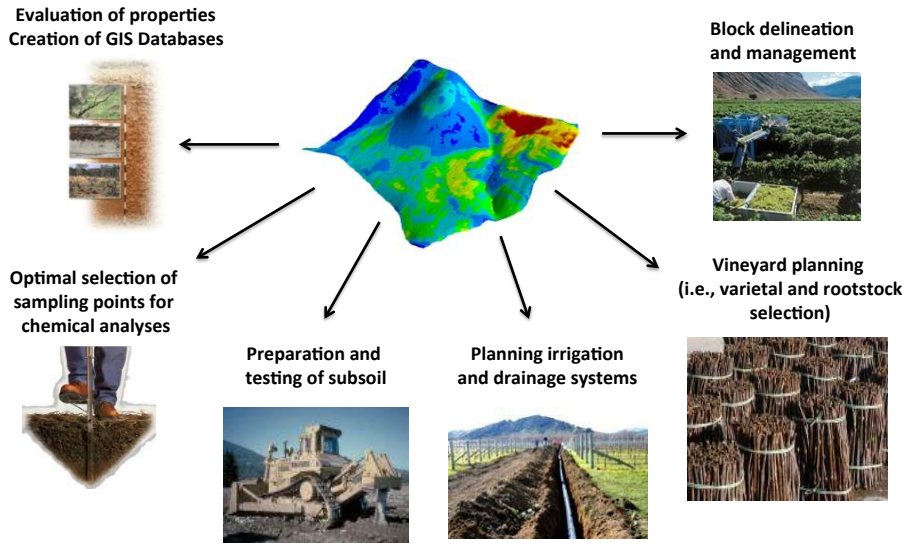
SOIL PROXIMAL SENSING SYSTEM:
Electrical Resistivity, Color, pH

MSP3™ on-the-go soil EC, OM and pH sensing system (VERIS)

Soil texture is derived from EC

- **6 electrodes for EC measurements: one pair for shallow (0-30 cm), one for deep (0-90 cm) measurements**
- **Optical sensor for OM: Red LED (660nm) and NIR LED (940nm)**
- **Soil sampling shoe 7 to 20 seconds cycle between samplings**
- **Antimony ion selective electrode for pH measurement on soil sample**
- **RTK (Real Time Kinematic) GPS receiver**

POTENTIAL APPLICATIONS OF SOIL PROXIMAL SENSING MAPS



PROXIMAL SOIL SENSING (PSS)

A DEVELOPING FIELD

- **PSS is defined as the use of field-based sensors to collect soil information from nearby (<2 m), or within the soil body.**
- **Proximal soil sensors allow rapid collection of precise, quantitative, high-resolution data, which can be used to better understand soil spatial and temporal variability and produce high resolution soil maps.**
- **PSS techniques: γ-rays (INS, TMN), X-rays (XRF, XRD), UV-vis-IR (UV, visible, NIR, MIR), microwaves, radio waves (TDR, FDR capacitance, GPR, NMR, EMI), ER (Electrical Resistivity, Gypsum block), Electrochemical (ion selective electrodes, ISFET) and Mechanical (mechanical resistance, fluid permeability).**

RADIO CONTROLLED AIRBORNE SENSORS
Smaller systems, more detailed imagery

RC PLANES AND DRONES

MULTISPECTRAL CAMERAS

RC HELICOPTERS

THERMAL IR CAMERAS

THE FUTURE OF PRECISION VITICULTURE?

- **PV has the capability to improve quality management and sustainability of production.**
- **Vineyard spatial variability has been shown to be stable in space, *but also in time,* because it is caused by soil, topography and aspect.**
- **New sensing systems, some portable, are under development for soil and plant analyses.**
- **More work is needed with respect to irrigation management, variable rate applications (fertilizer, other products), fruit yield and quality assessment, and disease monitoring.**
- **Data processing, integration and management will remain key.**