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How Soil Bioengineering Technology Combines Ecological Principles and Engineering Practices

TRIECA 2018 Conference

Brampton, Ontario Canada

Robbin B. Sotir - Robbin B. Sotir & Associates, Inc.
and
Anna Paris - Technical Dept. Maccaferri Canada

March 21, 2018

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Soil Bioengineering

is an integrated nature based technology using sound engineering practices & ecological principles to assess, design, construct & maintain dynamic watershed lands for the protection & enhancement of healthy functioning systems.

Soil Bioengineering follows the principles of Nature. (Sotir 2018)

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Approach

Soil Bioengineering integrates -

- **structural measures to provide mechanical foundations**
- **with & for, living vegetation,**
- **using live cut branches, woody & herbaceous plant materials**
- **specifically selected, arranged & embedded to assist in controlling:**
  - **shallow mass movement**
  - **water collection & transport**
  - **surface erosion – flood events, rill & gully**

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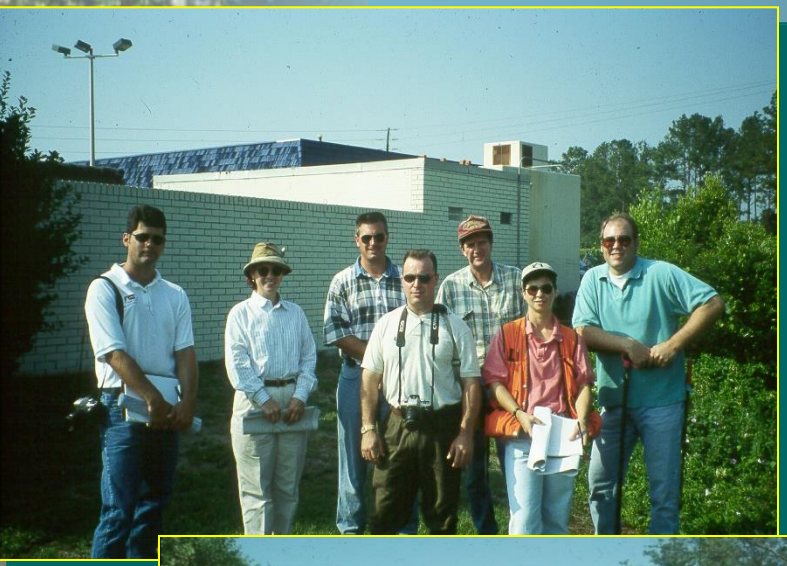
Design Development

Interdisciplinary Team Approach



Soil Bioengineering:

successful in a wide range of conditions, meeting specific multi-objective project goals.

However, it must be integrated with engineering, ecology, fluvial geomorphology, landscape architecture & other technologies.

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Living Components


Live Cut Branches


Rooted Plants

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Top Growth & Root Reinforcement

Structural Development

Living Root Mat

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Soil Bioengineering

Provides Strategies for Sustainable Systems

- Immediate & Long-Term Erosion Control
- Sets in Place Strong Foundations
- Improves Soil Mantle Strength
- Provides Strong Resistance to Flooding
- Enhances Ecosystem Diversity
- Supports Native Plants
- Speed up Natural Succession
- Improves Aesthetic Quality
- Low Life Cycle Costs

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Soil Bioengineering

Additional Environmental Benefits

- Improved Air & Water Quality
- Noise Reduction & Energy Absorption
- Air, Water & Soil Temp. Moderation
- Reduces Near Bank Velocities
- Optimizes Aquatic, Riparian & Terrestrial Connections & Wildlife Corridors
- Improves Infiltration Supporting the Ground Water Table
- Minimizes Mineral Contamination
- Enhances/Supports Surrounding Landscape

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Watershed Function

Function in nature implies optimum operational ability. Each element within the watershed is specifically adapted to perform a specific role.

Each role is synergistically interrelated and dependent upon another's role for it's existence …. thus keeping nature in balance.

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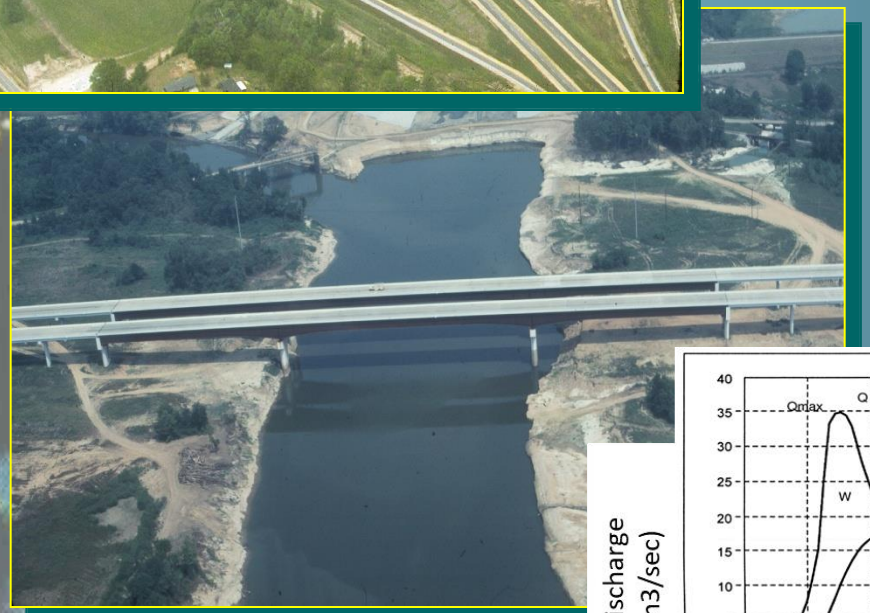
Anthropogenic Impacts

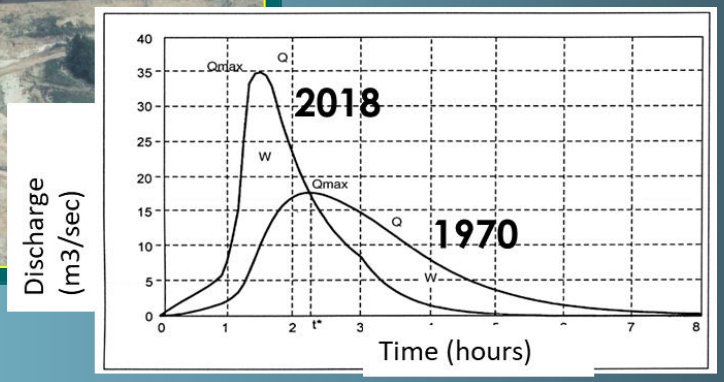


Watershed Alteration

Urbanization
Agriculture
Forestry
Mining

Channel Alteration

Flood Control
Hydropower
Navigation



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Conventional Methods Alone

- Stability & hydraulic efficiency
- Lacks social environmental, recreational & associated economic values
- Relating to quality of life

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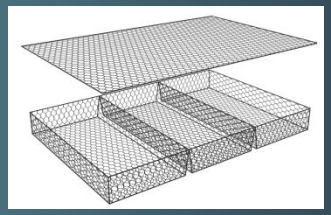
Conventional Engineering Combined with Nature Based Engineering Sets in Place Sustainable Mechanical & Ecological Foundations

Soil Bioengineered Systems



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Soil Bioengineering Provides Synergistic Composite Design

considerable functional improvement over either method used alone

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Soil Bioengineering

Bridges Ecology and Engineering

Respects land's dynamic synergistic nature, by going beyond viewing watershed systems as merely connected structures & further viewing them as living systems with interrelated functions. Sotir 2018

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Live Fascine

Jacque Cartier Park
Ottawa River, Quebec

First Season

15th Season

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Turf Reinforcement Mats

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Innovative Opportunities

Soil Bioengineering Systems

Reinforced Soil Slope +

Living Vegetation

- Strong foundations protecting highly steepened slopes
- Full watershed functionality
- Long-term ecological benefits

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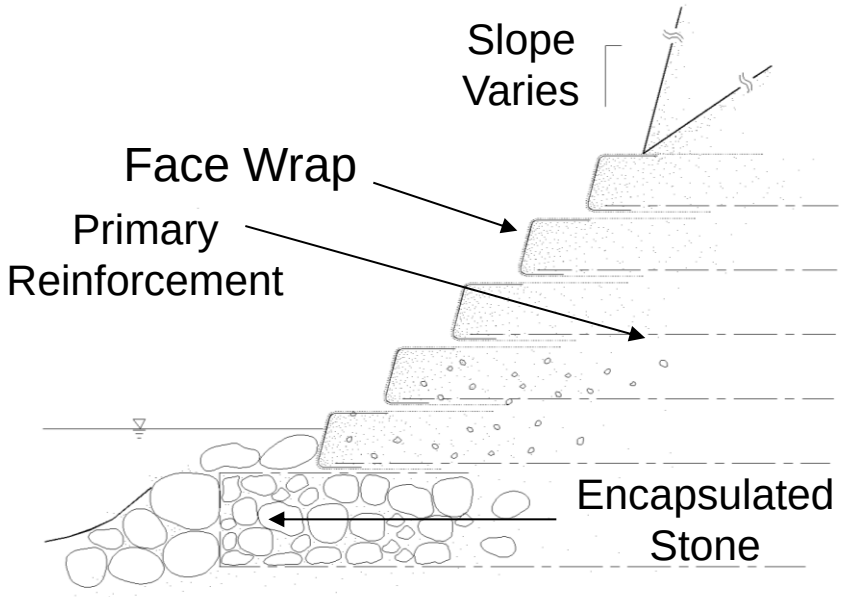
Living Structures

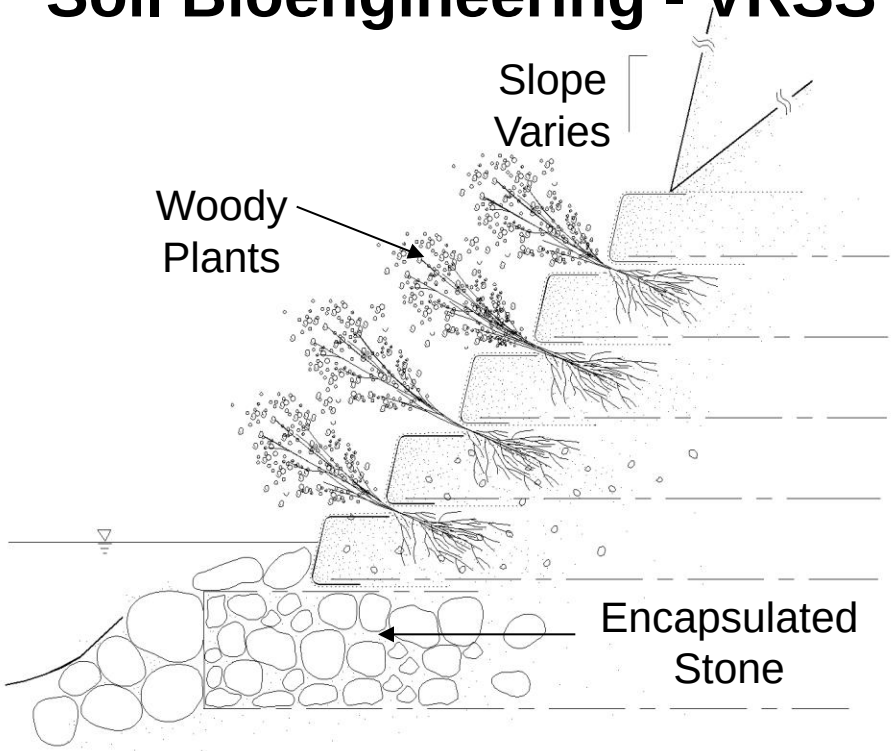
Vegetated Reinforced Soil Slopes

Reinforced Soil Slope

Conventional - RSS



Soil Bioengineering - VRSS



Inert/Dead

Living

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Vegetated Reinforced Soil Slope

Enables woody & herbaceous vegetation to be installed into highly steepened banks

Supports ecological function recovery,

As opposed to conventional monoculture grass treatments.

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VRSS Solutions

Aquatic, Riverine, Wetland, Terrestrial

- Highly Flexible, Advanced Channel Design Systems
- Provides Foundations for Ecologically Diverse Habitats & Wildlife Corridors
- Useful in Narrow Corridors where Land is at premium
- Fully Engineered Steep Slopes
  > natural angle of repose

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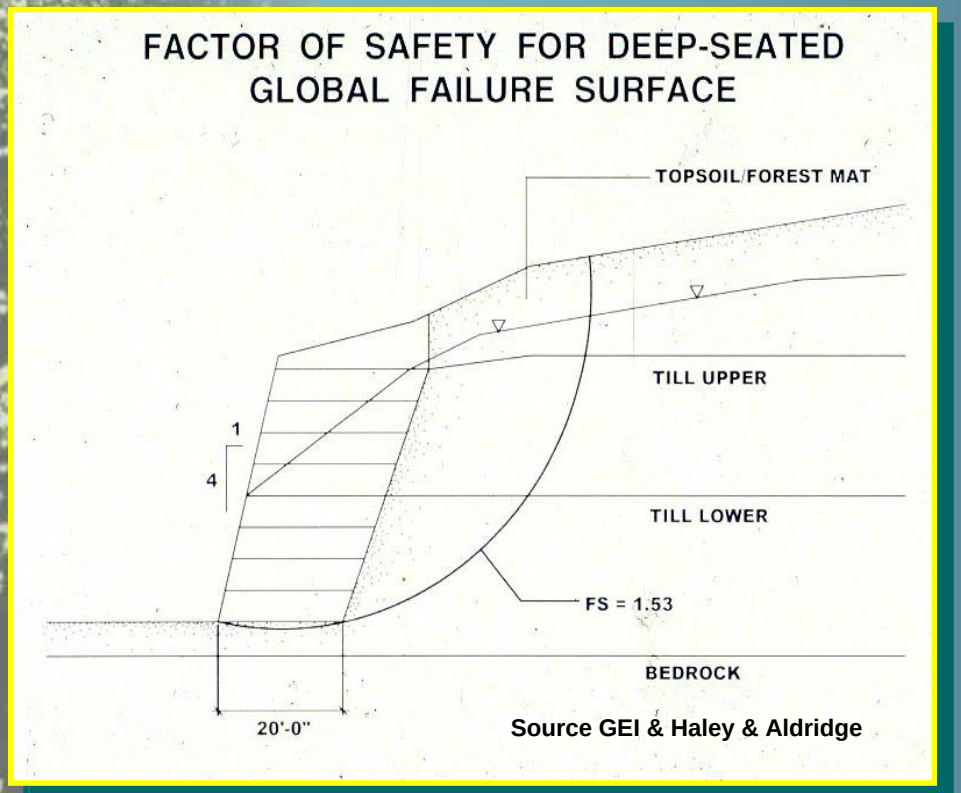
Geosynthetic Design



- Geosynthetic reinforcement is carefully selected & located for structural stability
- Vertical spacing is reviewed based on engineering design requirements

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Agronomic & Geotechnical Considerations

Plants Require Sufficient Fines to Provide Moisture & Nutrients

- May require slight modifications in backfill specifications
- Allow for some non-plastic fines (Silts) in the backfill frontal zone
- Both agronomic & geotechnical desire a well-drained backfill

Drainage Design

Soil bioengineering augments drainage

Conventional drainage features are required

- Flow rate
- Filtration
- Placement
- Outlet details

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Vegetated Reinforced Soil Slope - Italy

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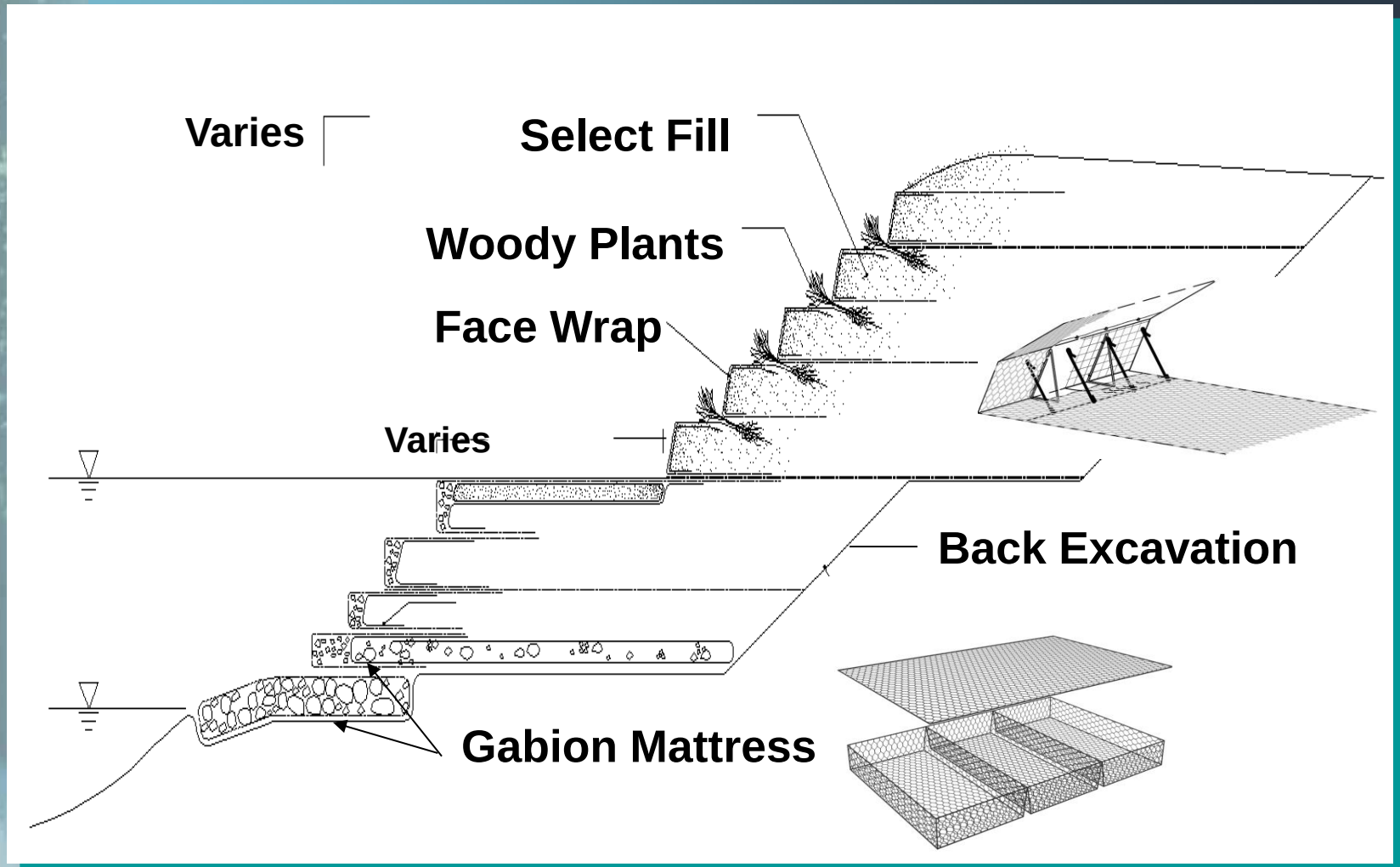
Vegetative & Structural Versatility



VRSS Development

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Conventional Walls & VRSS Systems

Critical Issue	Walls (Concrete, Armor Stone)	VRSS
Vegetation Potential	Poor to None	Excellent
Ecological Function	Poor to None	Good- Very Good
Aesthetics	Moderate[1]	High
Risk of Failure	Low/ Moderate[2]	Low
Structure	Rigid	Flexible (V&H)
Water/Air Temp. Mod.	Increases	Moderates
Energy Dissipation	Increases (Deflection)	Reduces (Absorption)
Ice Action	Pushing/ Uplifting	Relieve Pressure
Maintenance	Low-High	Moderate[3]

Sotir 2018

[1]textured or stone armor are appealing; [2]distortion & break-up due to ice & wave action; [3] pruning, remove non-natives

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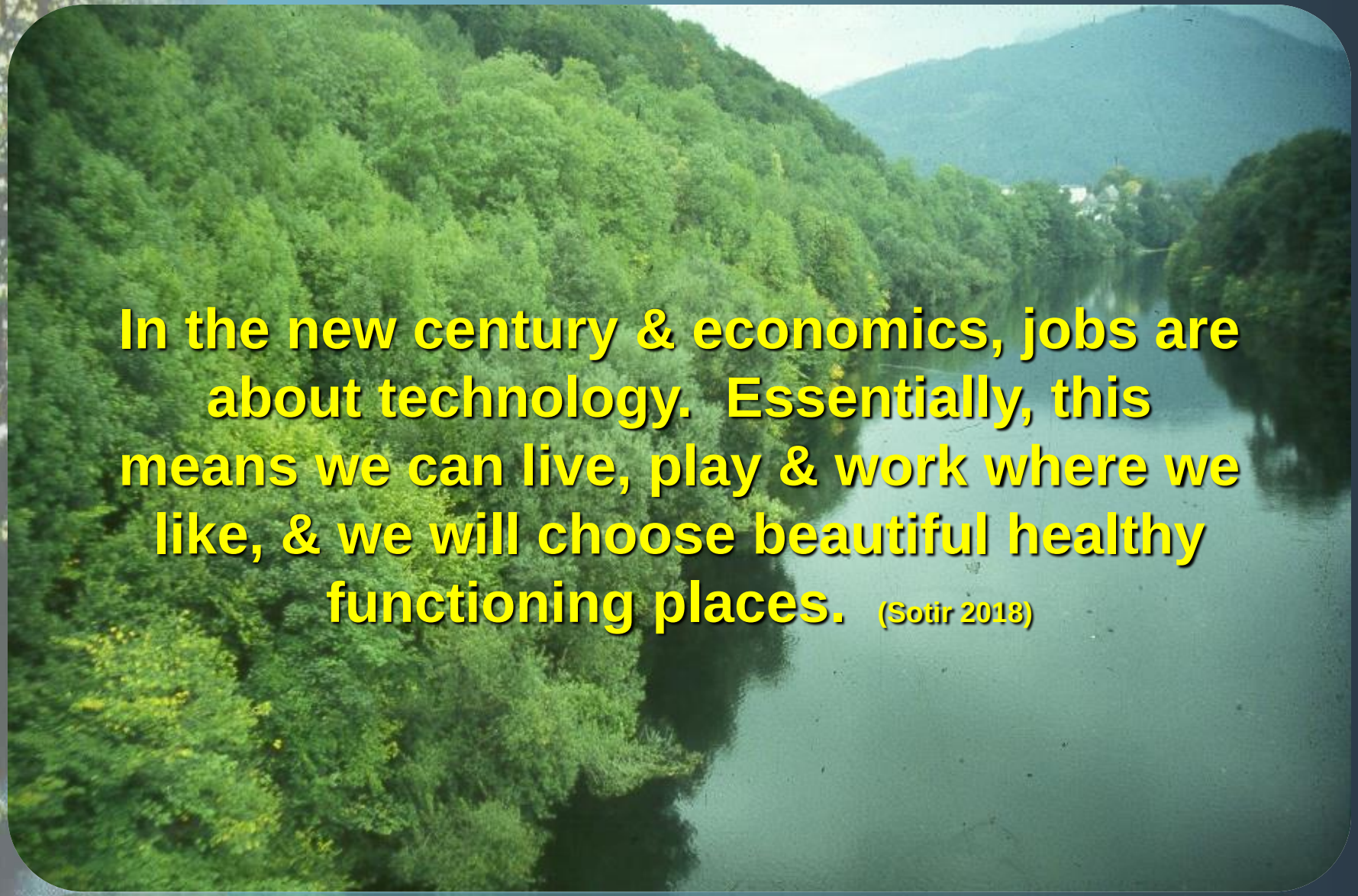
Summary

Soil Bioengineering Technology offers a synergistic composite design with considerable function improvement over either method used alone. Sotir & Christopher 2000


In the new century & economics, jobs are about technology. Essentially, this means we can live, play & work where we like, & we will choose beautiful healthy functioning places. (Sotir 2018)

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