Sustainability: *"Life, Liberty and the Pursuit of Negative Entropy"* Part 2: Transportation, Resiliency and Artificial Intelligence

John Milne

Clark County Public Works
Vancouver, WA, USA

EDINBURGH LIKE DUNEDIN, BUT FURTHER

Does your community need a…..

- Sustainable land use plan?
- Sustainable roadway grid?
- Strategy for climate change?
- Strategy for driverless cars?

Are your.....

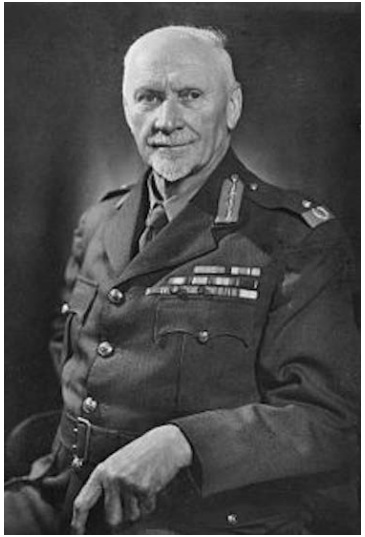
- Commutes miserable?
- Air quality alert days increasing?
- Wetlands drying up?
- Summer stream flows lower and more polluted?
- Wells drying up?

.....entropy-based resource management is for you!

Concept

Sustainability

"Mr. Malthus – meet Mr. Smuts"



http://centerforsi.org/index.php/2018/05/11/clark/

Entropy-based resource management

- Natural processes always minimize energy loss and leave all resources in a *state of minimum entropy* afterwards
- The resource is always maintained in its highest, most ordered state, at the highest energy level possible

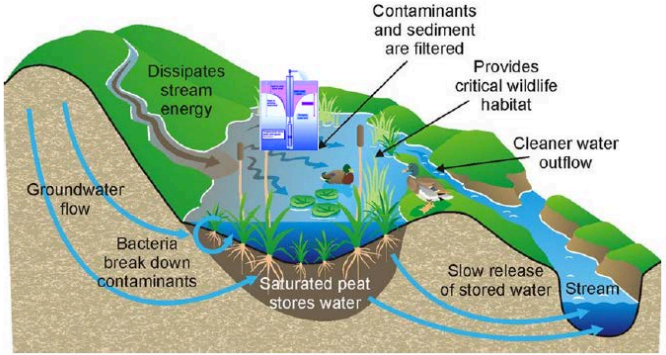
Try to create and maintain order, to *"create negative entropy"*, in all things, in all places, at all times

Natural Examples

1. Snowpack

Water in solid phase at the highest possible potential energy

….next best thing??



2. High groundwater

Water in liquid phase at the highest possible potential energy

"Pump up the groundwater (then plant everywhere)"

The effective storage and frugal use of our natural resources:

- Use those resources we need to live sparingly
- When you've got too much, store some for later when you'll need it more

Organizing principle??

"Just roll the bloomin' snowball down the hill!"

Part 2 Literature Review

Entropy-based transportation strategies

Transportation planning: *"A tale of two entropies"*

1. *Minimizing* entropy in traffic management: *Reducing energy use*

"About the analogy between optimal transport and minimal entropy";
(Gentil et al., 2016)

2. *Maximizing* entropy in traffic management; *Optimizing choice* in transportation options and routes

"Maximum Entropy and Utility in a Transportation System";
(Mazumber et al., 1999)

Other entropy-based traffic management techniques

3. “Entropy in urban systems”, (Cabral et al., 2013)
4. “Concept of transportation entropy and its application in traffic signal controls”; (Zhou et al., 2013)
5. “Cost-minimizing choice behaviour in transportation planning”; (S.B. Erlander, 2010)
6. “Entropy-based transportation model; a geometric programming approach”; (Samata et al., 2003)

Entropy-based transportation strategies

Application to other current issues

Transportation planning and land use

"Maximum Entropy and Utility in a Transportation System"; (Mazumber et al., 1999)

"Both entropy and utility can be adopted by skilful proponents to explain almost any form of transportation problem".*

*Utility = benefit from making economic choices such as home and workplace location. Important in land use planning.

Resiliency (to climate change)

Sustainability and resiliency are essentially two sides of the same coin, having essentially the same solutions:

Electric vehicles:

- use less energy (sustainability)
- produce less greenhouse gases (resiliency)

Low Impact Development techniques:

- recharge groundwater supplies (sustainability)
- reduce flooding (resiliency)

Plus...emphasis on quick on-the-ground action can help meet urgent resiliency needs.

Driverless cars and autonomous vehicles

- Entropy-based transportation strategies can establish energy-efficient *transportation networks,* for all types of vehicles
- *In the vehicle*, entropy-based (energy usage) algorithms can help optimize travel route choices

Smart Infrastructure and Artificial Intelligence

- Smart infrastructure can be the on-the-ground embodiment of well planned, entropy-based resource management systems
- Artificial Intelligence software can make the operation and maintenance of smart, entropy-based public infrastructure easier and more efficient

Entropy-based resource management

“Back-to-basics sustainability”

"The Sustainable City"
Entropy-based Resource Management Plan

Energy

Water

Air

Energy

Employ entropy-based transportation strategies to minimize the work needed for home-to-work travel and all other trips.

Develop energy-efficient (low pollution) vehicles to perform that work as efficiently as possible.

Supporting strategies:

- *Multi-modal transportation systems*
- *Replace fossil fuels with renewable energy*

Implementation measures:

- *Sustainable land use plan ("Smart Growth" plan)*
- *AI-enhanced "Smart City" infrastructure and operations*

Other compatible strategies:

- *Complete Streets, driverless cars, First Mile travel options, 20-minute Neighbourhoods, roundabouts, entropy-based limits on sprawl, etc.*
- *Solar energy, wind energy plus pumped storage, better batteries, artificial photosynthesis for fuel, etc.*

Water

Establish and maintain high groundwater elevations in all places at all times.

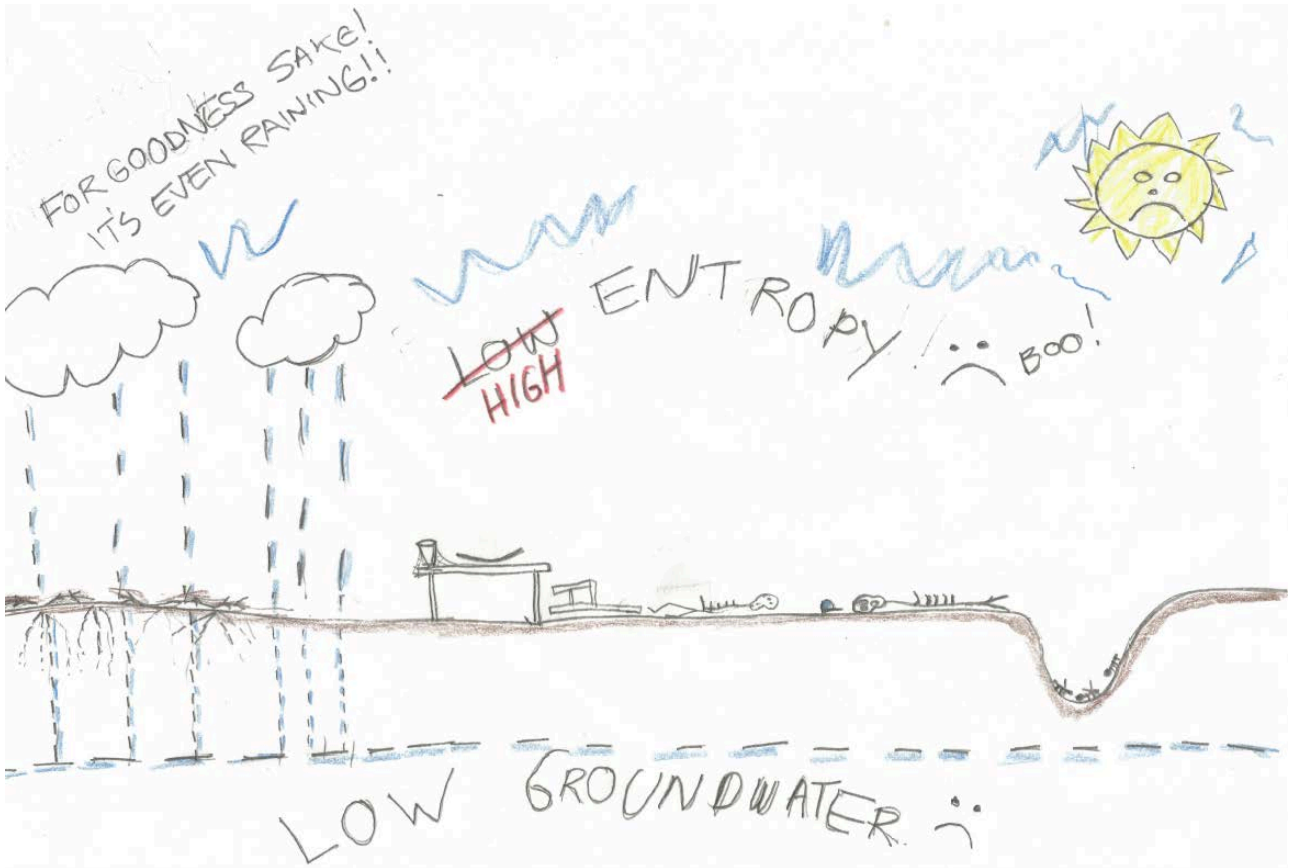
(Maximize retention of the annual rainfall supply/maximize the availability of water throughout the watershed)

Water:

Low entropy >
high groundwater ☺

Water:

High entropy >
low groundwater ☹



Supporting strategies:

- *Infiltration-retention-detention hierarchy for stormwater*
- *Flood flow capture and aquifer replenishment*
- *Headwater wetland restoration projects*
- *Trench dams in pipeline and utility trenches*
- *Runoff flow control*

Implementing measures:

- *Sustainable land use plan (incorporating "envirometric overlay")*
- *"Pump up the groundwater then plant everywhere"*

Other compatible strategies:

- *"One-Water" strategies, Low Impact Development BMPs, "Green Streets", "Smart City" infrastructure, "Streamflow restoration grants"*

Air

Increase photosynthesis

Reduce greenhouse gas emissions

Supporting strategies:

- *Entropy-based watershed management strategies*
- *Entropy-based transportation strategies*

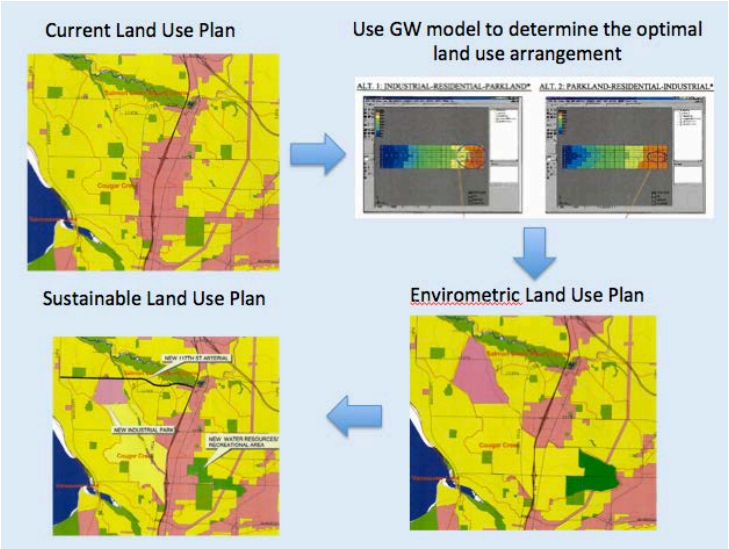
Implementing measures:

- *Sustainable land use plan (incorporating an "envirometric overlay")*
- *"Pump up the groundwater then plant everywhere"*

Other compatible strategies:

- *Electric vehicles, Reforestation*

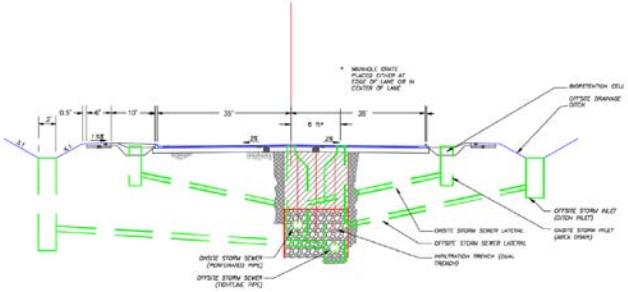
Smart "Smart Cities".....



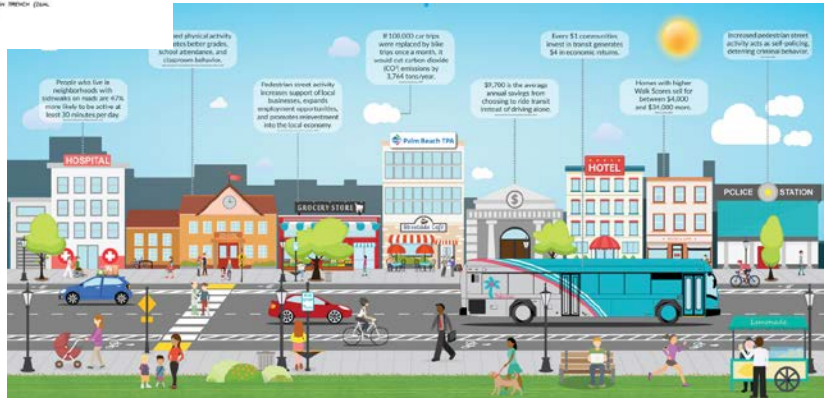
"Smart Growth" comprehensive plan

"Smart City" infrastructure

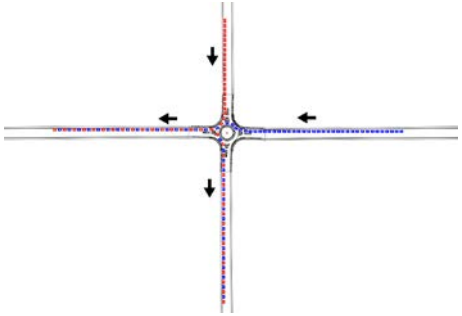
...with Green "Complete Streets"



Green Street

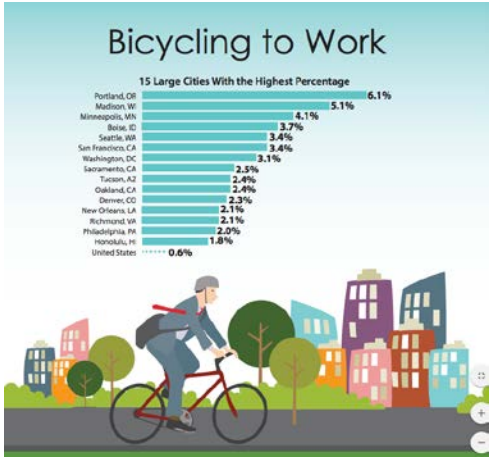


Complete Street...



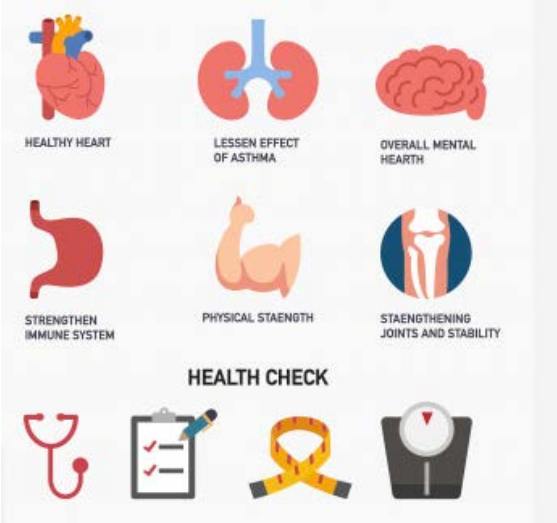
(...including roundabout corridors)

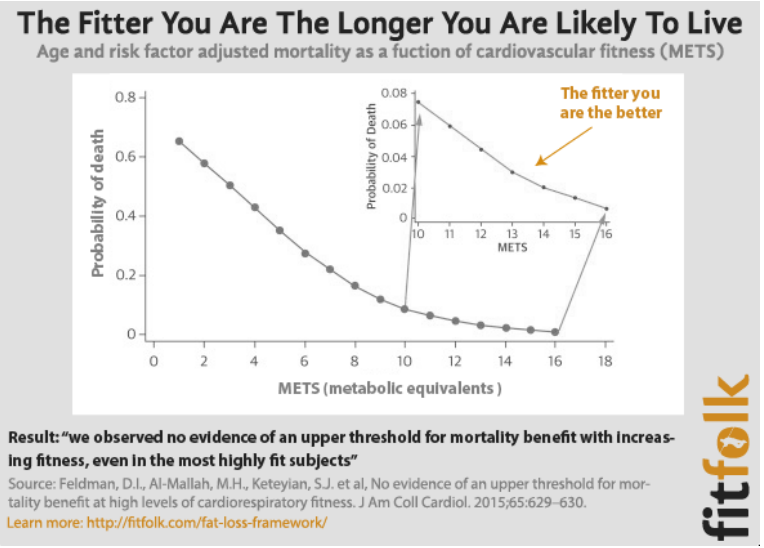
A holistic strategy: *design for Liberty…*



Multi-modal transport options – *use food energy first…*

.... you get Life too!

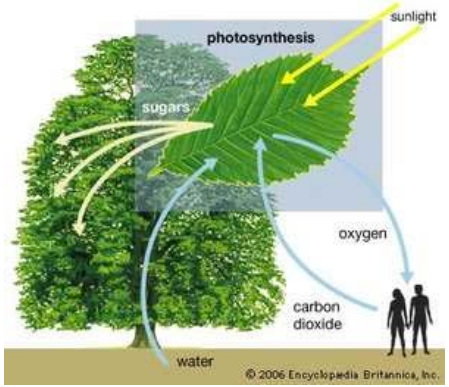




....folk are healthier and live longer

Sustainability for America!

"Life"



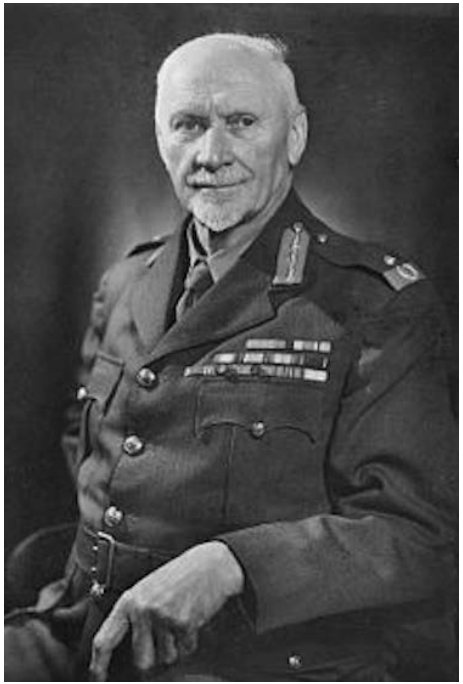
... and the pursuit of...

"Negative Entropy"

"Liberty"

Sustainability, mate???....

...a half-decent strategy and some good teamwork – that'll get the job done!



"When we try to pick out anything by itself, we find it hitched to everything else in the Universe"
- John Muir

"The ultimate purpose of life, mind, and human striving: to deploy energy and information to fight back the tide of entropy and carve out refuges of beneficial order" - Steven Pinker

(For more information, go to: https://www.clark.wa.gov/public-works/accreditation)