Euro-CASE

Austrian Academy of Sciences

The economical challenges towards sustainable sludge management

Dr Tim Evans

Stonecroft, Park Lane, Ashtead, Surrey, KT21 1EU England tel/fax 00 44 1 372 272 712

“Wastewater Sludge as a Challenge"

Vienna, 25 June 2001

A Euro-CASE Workshop sponsored by the Austrian Academy of Sciences

tim.evans@messages.co.uk

TIM EVANS
ENVIRONMENT

Economics

Systematic study of the distribution of [scarce] resources between alternative uses

TIM EVANS
ENVIRONMENT

What do we mean by *sustainable* ?

how about something like this?

Actions today that will not compromise the freedom of action of future generations

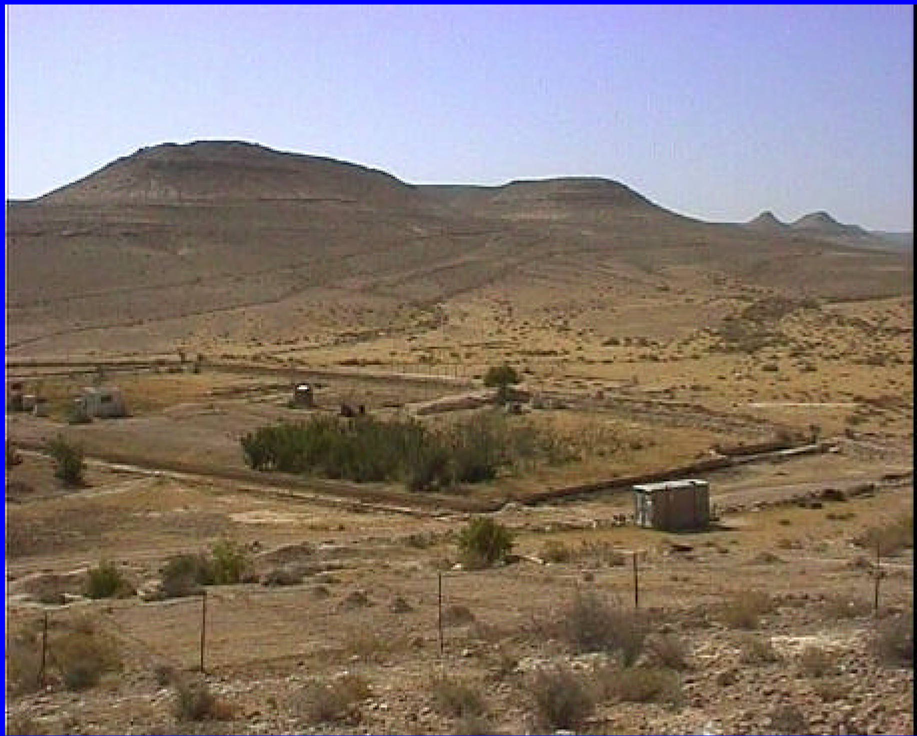
that is not “no change”

TIM EVANS
ENVIRONMENT

Sustainability

- sustainability and economics are about choices
- human activity changes the planet
- some of the things we treasure have caused dramatic changes

TIM EVANS
ENVIRONMENT



Nabataean rainwater harvesting to create a farm and way-station in the desert 2000 years ago

Conifer forestry creating podzol soils and acidifying surface waters

Clearance of forests for grazing and later dry stone walls to enclose improved pastures in the Yorkshire Dales

TIM EVANS
ENVIRONMENT

Sustainability and wastewater biosolids 1

- treating wastewater is vital for a sustainable aquatic environment
  - climate change and increasing population will demand better stewardship of fresh water
- treating wastewater is vital for sustainable urban living and for public health
- biosolids are inevitable products of wastewater treatment
- wastewater treatment can't operate properly unless the biosolids are managed properly

TIM EVANS
ENVIRONMENT

Sustainability and wastewater biosolids 2

- many [old] books on wastewater treatment contain process diagrams that show an arrow marked “to disposal”
- this is no longer acceptable
- biosolids management has/will/should become a proper process

TIM EVANS
ENVIRONMENT

Sustainability and wastewater biosolids 3

biosolids comprise

- organic and mineral matter from the wastewater
- biomass grown during the treatment process

the combined solids are 20% inorganic, 80% organic before any further treatment

TIM EVANS
ENVIRONMENT

Sustainability and wastewater biosolids 4

biosolids contain constituents from wastewater that:

- are sorbed onto the solid phase of the wastewater
- are incorporated into the microbial biomass during wastewater treatment

they have limited solubility

- otherwise they would be in the effluent
- so it is only the solubilised fraction that can be taken up by plants

TIM EVANS ENVIRONMENT

Sustainability and wastewater biosolids 5

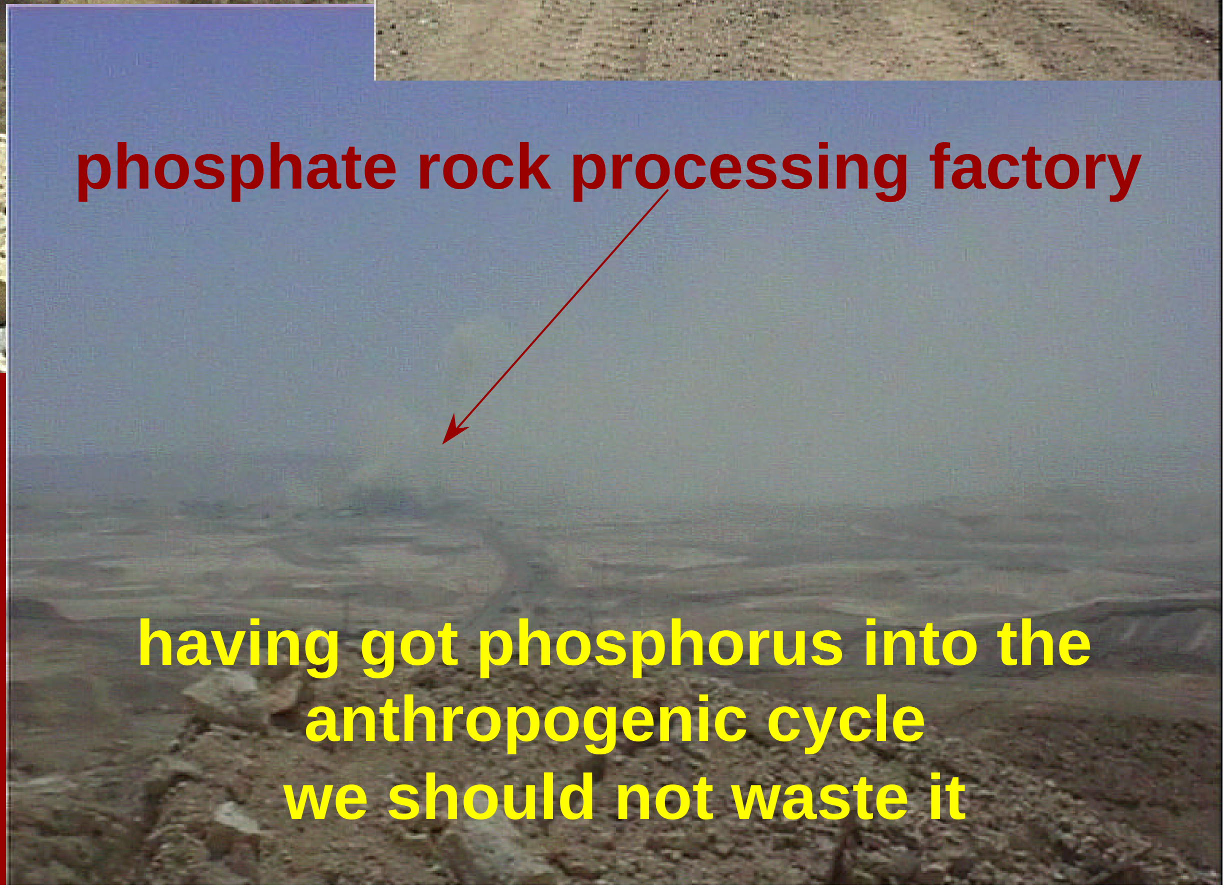
- some of the constituents of biosolids are valuable resources
  for example:-
  - energy
  - phosphate
  - organic matter in areas where soil is depleted

TIM EVANS
ENVIRONMENT

Using **energy** recovered from biosolids as biogas (circ1941)

It is not new but perhaps we have learnt to do it better!?

TIM EVANS
ENVIRONMENT

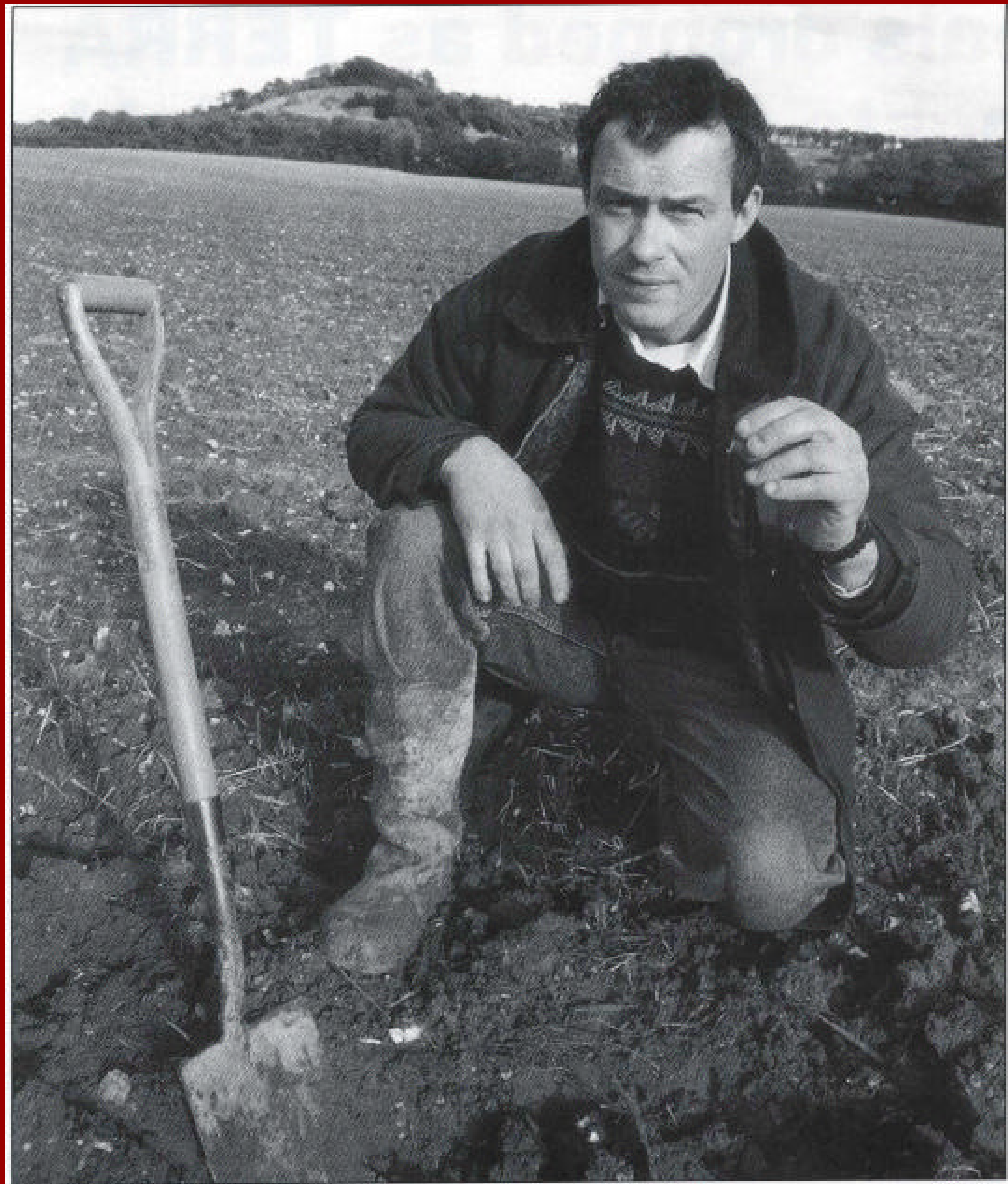


biosolids recycling conserves P

Phosphate - a sustainability issue

- It is one of the major agronomic benefits of biosolids
- P is fundamental to biochemistry - no substitute
- world's economic reserves estimated at 100 years
- P is essential for crop yields but availability in soils declines with time
- P in water results in eutrophication
- P-removal limits on WWTW (P added to water supply)
- Sweden advised 15 Environmental Objectives; one is "x% P in wastes and drains should be recovered in y years"

TIM EVANS
ENVIRONMENT



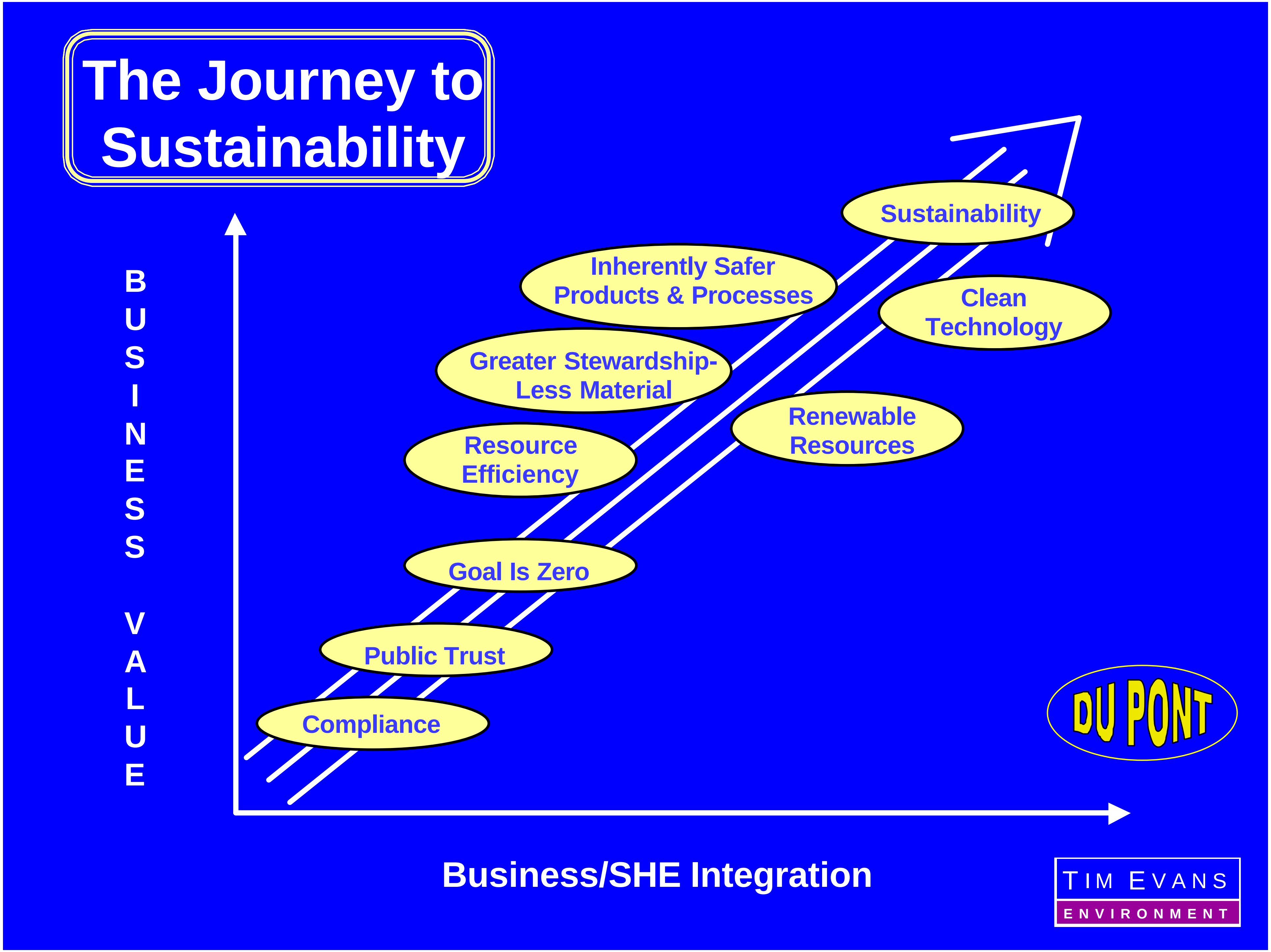
A farmer demonstrating that the application of biosolids has brought life back to his soil by supplying **organic matter** that increased earthworm populations

TIM EVANS
ENVIRONMENT

Not compromising soil function

- We know biosolids increase crop yield and can improve crop health [=less pesticide]
- we know biosolids at operational rates don't adversely affect the soil microbial respiration quotient, which is a very sensitive measure of adverse impact,
- what do we know about the impact on soil microbial biodiversity? The answer is we don't yet understand the reference states so we don't know what is "good" or "bad".

TIM EVANS
ENVIRONMENT


The Journey to Sustainability
BUSINESS VALUE
Compliance
Public Trust
Goal Is Zero
Resource Efficiency
Greater Stewardship- Less Material
Inherently Safer Products & Processes
Renewable Resources
Clean Technology
Sustainability
Business/SHE Integration
DU PONT
TIM EVANS
ENVIRONMENT

GOOD FOR BUSINESS &

GOOD FOR THE ENVIRONMENT

DU PONT

1986-1997

Total Shareholder Return	**Up 400%**
Footprint	
I,I,I,W&E	**Down 60%**
Depletable RM&E	**Up 40%**

I,I,I,W&E = injury, illness, incidents, waste & emissions
RM&E = raw materials & energy

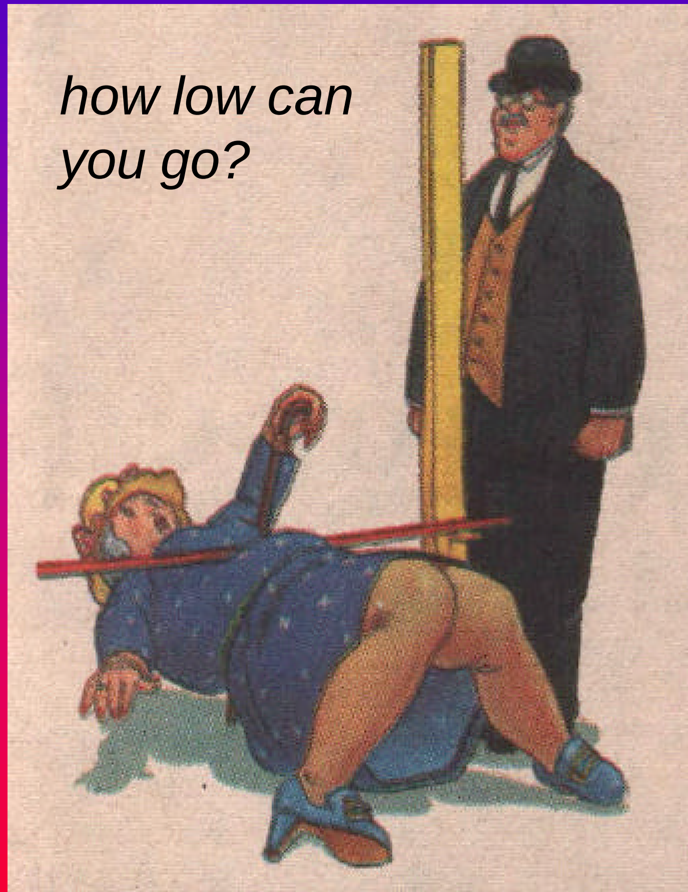
Waste management hierarchy to guide strategic decisions

- Avoidance & Minimisation
  - we can manipulate animal diets but humans would object
  - but sludge minimisation processes are being researched
- Reuse & Recyling
  - generally considered the BPEO for biosolids
- Disposal with Energy & Resource Recovery
- Disposal by Incineration or Landfill

TIM EVANS
ENVIRONMENT

Some say biosolids recycling is a good thing - others say it isn't!

- **Some say "biosolids are a source of pollutants"**
- **Some people are hung up about "heavy metals" and chemical hazards**
- **Some say "My biosolids / regulation is better than yours because it's got less / permits less -- " the same argument is applied to composting - in some countries *Solanaceae* are not composted because they are high in copper, which is natural**



TIM EVANS ENVIRONMENT

Hazards(the potential to do harm)

- Risk - the likelihood of harm occurring
- Life is not risk free
- SAFE is a 4-letter word - airlines don't use it
- metals, now at levels where risk is trivial
- organic micropollutants
  - more than 50% of chemicals (sysnthetic or natural) come out as carcinogenic in high dose animal cancer tests
  - 70% of chemicals in roasted coffee are carcinogenic
  - Professor Bruce Ames "anthropogenic chemicals have been a distraction"

TIM EVANS ENVIRONMENT

Hazards of biosolids (2)

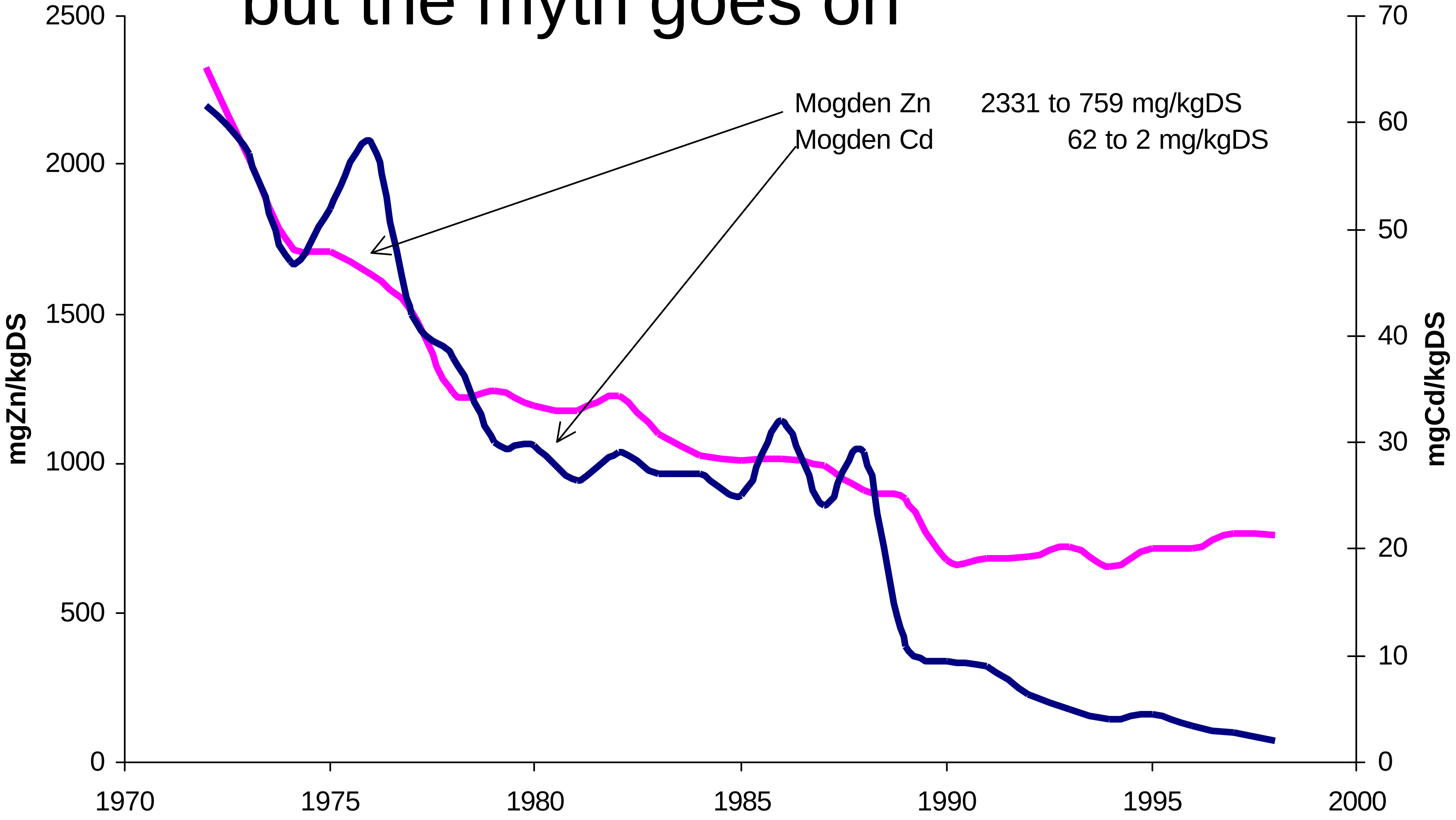
- Legal non-compliance
- Chemical
- Litter
- Sand & Grit
- Biological
- Water pollution
- Odorants
- Legal action
- Loss of reputation
- Loss of market
- Damage to balance sheet

TIM EVANS
ENVIRONMENT

Risk management

- Control of point sources is a success

but the myth goes on



Dioxin in forensic samples of biosolids control as a result of legislation

Date	Dioxin total TEQ (ng/kgDS)
1942	18
1944	36
1949	61
1953	127
1956	402
1958	229
1960	166
1998	4.2

TIM EVANS
ENVIRONMENT

Risk or Precaution

(*To limbo dance or not to limbo dance? That is the question*)

- e.g. Copper & Zinc
  - both are micronutrients that are deficient in many soils, but in excess they are phytotoxic
  - source control of industry
  - diffuse input from copper pipes creates a base load
  - some medics are concerned about zinc deficient diets
- the choice of limit values is ultimately political and will determine the cost - partly
- we need strategies to ensure compliance

TIM EVANS
ENVIRONMENT

Biological hazards

- diffuse inputs
  - disease epidemic
- point sources - e.g.
  - VTEC
  - plant pathogens
  - black grass

Hazard Analysis and Critical Control Point (HACCP)
a better way to design processes

- Developed 1960s and now used throughout the world for food safety
- Introduced to UK Water Industry by Food Industry
- Demonstrates due diligence
- Proactive & non-prescriptive
- Does not inhibit innovation

TIM EVANS
ENVIRONMENT

HACCP (2)

- What are you trying to make?
- What are the hazards?
- What is the process?
- Look at each step of your process - can it control a hazard to an acceptable level of risk? If the answer is YES it's a Critical Control Point
- Decide operating conditions that control risk - these are the "Critical Limits". If the operating conditions don't go outside the CL, and if you record them, you know the hazard is controlled and you have traceability.

TIM EVANS
ENVIRONMENT

HACCP (3)

- if you have a CCP it means you have analysed the situation and defined a place where risk is controlled
- misunderstanding
  - 6-log reduction
  - but I don't have 6-log to start with
  - 6-log reduction <u>capability</u>
- HACCP compliments Quality Assurance - if you don't have QA how can you expect to get consistent results?
- It gives locally appropriate solutions

Policy makers can't do everything

- they can only set the rules
  - obeying the rules doesn't guarantee acceptance
  - there are no prizes for not breaking the law !
- biosolids producers need to communicate with the public and stakeholders to gain their acceptance
  - in Canada and USA incinerators have been closed because of public opposition
  - in some areas the use of biosolids on land has been restricted by food industry's or landowners' fears

What do stakeholders want?

No compromise of my own interests:-

- not having my pleasure of my house or garden reduced by offensive odour
- not risking the health of me or my family by air, water, or food contamination
- not risking my brand by the possibility of a claim that the food I sell / make is contaminated
- not risking the value of my land, perhaps by a pollutant of which we are not yet aware
- not reducing my ability to sell my produce

Stakeholders

- they share a responsibility for biosolids
- it is not their fault if they don't know the truth about biosolids production, use and disposal
- first they need to be aware of the truth about the use and disposal of biosolids, not myth and junk-science
- then discuss with them their remaining concerns and agree an action programme to resolve differences

Costs 1

Costs depend on:

- local geographic situation
- local regulations
- local tax situation
- size of works
- where you draw the boundary for cost comparison
  - per tonne dry solids of liquid raw sludge is probably best
  - and include the cost of land used for treatment
  - and take it to final destination

TIM EVANS
ENVIRONMENT

Costs 2

Thermal destruction is probably the most expensive.

- Incineration - economies of scale. Ash has little value
- Gasification probably scales down better than incineration but no sludge installations. It falls within the Incineration Directive
- Oil from Sludge - first full scale plant (250k pe)
- Deep shaft - practical problems
- Supercritical water oxidation - only pilot scale € 225/tDS
- Co-combustion in power station, cement plant, brickworks, light weight aggregate. Ash is “lost in product”. Facility will be brought into the Incineration Directive. Gate fee depends on market

Some of these will be penalised by climate change levy, others will benefit

Loses P unless it is recovered

TIM EVANS ENVIRONMENT

Costs 3

Landfill cost is probably intermediate between destruction and utilisation

- depends on:-
  - local tax regime
  - whether landfilling sludge is permitted under local implementation of Landfill Directive
  - local market price for landfill space
- co-disposal in landfill can maximise rate of stabilisation of waste - and minimise time for site to be useable
- loses P unless it is recovered before landfilling

Cost 4.1

Beneficial use on land is probably the least expensive

- several sludge preparation alternatives
  - anaerobic digestion
    - produces biogas - good carbon credit
    - limited sanitisation unless combined with >~55ºC
  - composting - good sanitisation
    - emits CO_2 and uses energy
    - produces stable product with “magic” properties
  - lime stabilisation - good sanitisation
    - lime production uses energy
    - product might smell and might be “Special Waste”
  - thermal drying - good sanitisation
    - it takes more energy to evaporate water in cake than to haul it
    - climate change levy will increase cost

TIM EVANS ENVIRONMENT

Cost 4.2 beneficial use continued

- Select the preparation alternative appropriate to the needs of your intended market(s)
- It is a sales and distribution operation;
  - treating it that way will minimise costs and maximise market share
  - understand the features and benefits of your biosolids and match them to the needs of your market

TIM EVANS
ENVIRONMENT

Sustainability scores

Thermal destruction	Low score even with P and energy recovery
Landfill	Low score unless P is recovered and landfill gas is used
Beneficial use on land	Probably scores best, conserves organic matter and completes nutrient cycles

TIM EVANS
ENVIRONMENT

Conclusions

The economical challenges towards sustainable sludge management

- The answer is very dependent on the interpretation of "sustainable"
  - There has been a huge amount of scientific research into the subject (>50000 papers) but are we prepared to base policy on it?
  - We don't know everything - but we do know a lot
  - The Communication on the Precautionary Principle recommends policy should be proportionate to risk and based on science
  - The Environmental Liabilities White Paper recommends producers should have strict liability for any adverse effects attributable to their actions

Conclusions

- All parts of society have a responsibility for biosolids - will all parts accept their part in the solution?
- Communication with stakeholders has a vital role in achieving strategies with longevity
- Key sustainability components would appear to be:-
  - treating and recovering wastewater
  - controlling the risk of disseminating disease,
  - minimising climate change effects,
  - using organic matter to improve soils,
  - controlling the risk of compromising soil functionality,
  - completing nutrient cycles,
  - trust and acceptance by the public and other stakeholders

tim.evans@messages.co.uk

TIM EVANS
ENVIRONMENT