Two extravagant ideas on

Global Warming

and

Cooling Holland

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Thomas Colignatus is the preferred name of Thomas Cool in science.

The update in 2013 concerns only the introduction of Figure 6 and Figure 8 around Figure 7.

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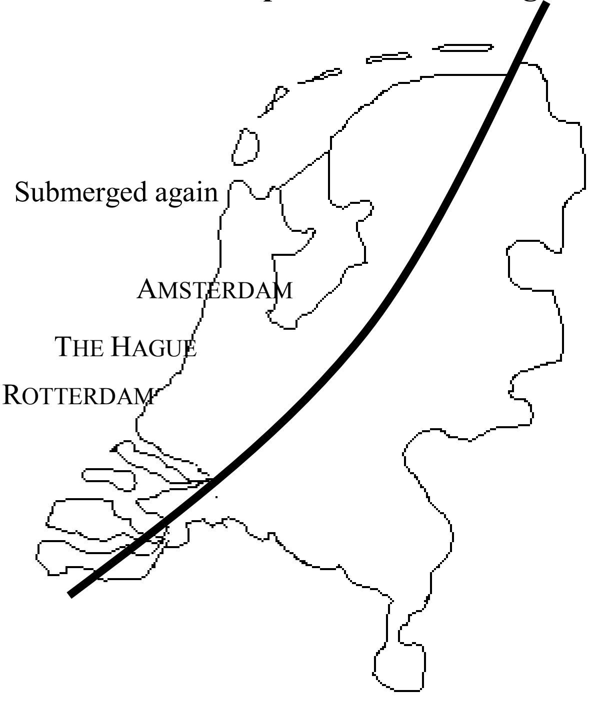
1. Introduction

The country of the Netherlands – also called "Holland" after the provinces where Amsterdam and The Hague are located that dominated its history – is reported to be at risk of being flooded again as a result of global warming. [1] What part of Holland would be flooded at what particular moment in time depends upon the degree of global warming, on how much and how fast the thermal expansion of the oceans will be, on the amount of landed ice on Antartica and Greenland, and on the capacity of the Dutch to raise their dikes. Figure 1 gives my impression of what it might look like. [2] Actually, my home in Scheveningen is on a dune at the beach by The Hague, some 4 meters above the sea level, and its property value at this moment of writing still is decent.

Figure 1: The author's impression of submerged Holland [3]



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[1] See Stern (2006) and Gore (2006) though the risk was known before, see NEAA / RIVM (2004), Vis et al. (2003), or http://www.cpb.nl/nl/news/2006_16.html

[2] See http://nl.wikipedia.org/wiki/Nieuw_Amsterdams_Peil, http://www.ahn.nl/
en.wikipedia.org/wiki/Sea_level_rise,
http://www.giss.nasa.gov/research/news/20060925/
http://geongrid.geo.arizona.edu/arcims/website/slr1kmglobal/viewer.htm
http://maps.grida.no/go/searchFree/q/climate+change
http://maps.grida.no/go/graphic/sea_level_change_estimations_and_predictions
http://www.gfdl.noaa.gov/~tk/climate_dynamics/climate_impact_webpage.html#section4

[3] Hand drawn. The distance from Amsterdam to The Hague is about 50 kilometers.

Figure 1 actually shows the current situation when Holland wouldn't have dunes and dikes at an unchanged sea level. The line would move to the right when the sea would rise and Holland wouldn't be able to keep up. At one point the dikes would give way, causing a major flood.

There are not only dikes on the sea shore but also along the inland rivers and canals. The port of Rotterdam is important for Germany and other parts of Europe. It would cost the Germans a lot to create a similar port more inland. Of course, we may be speaking about 2050 when I may no longer be alive.

☙

Flooding as a result of global warming will affect many other areas of the world. The following discussion will neglect those areas but it may be hoped that they might derive some inspiration from the example by Holland.

We will also neglect other related issues. One story is that in 50 years the seas will be deplete of fish so that there is little use for Scheveningen harbour. [4] There is also a report that by 2040 the North Pole might turn into a sea during Summer. [5] One can imagine that this would affect the weather and all kinds of related issues. Yet for now we just consider the rise of the sea level.

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It is actually rather difficult to get a more precise summary of what one might expect for the rise of temperature and sea level. A useful quote is from the National Geographic: [6]

> "So far, the rise in sea level is because warmer water takes up more room than colder water, which makes sea levels go up, a process known as thermal expansion.
>
> "The real question is what's going to happen to Greenland and Antarctica," Stouffer said. "That's where the bulk of all the fresh water is tied up."
>
> A recent Nature study suggested that Greenland's ice sheet will begin to melt if the temperature there rises by 3 degrees Celsius (5.4 degrees Fahrenheit). That is something many scientists think is likely to happen in another hundred years.
>
> The complete melting of Greenland would raise sea levels by 7 meters (23 feet). But even a partial melting would cause a one-meter (three-foot) rise. Such a rise would have a devastating impact on low-lying island countries, such as the Indian Ocean's Maldives, which would be entirely submerged."

Wikipedia [7] refers to this report: [8]

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[4] http://news.bbc.co.uk/2/hi/science/nature/6108414.stm
[5] http://www.nytimes.com/2006/12/12/science/earth/12arcti.html?em&ex=1166072400&en=5fe8e0f82496ac54&ei=5087%0A
[6] http://news.nationalgeographic.com/news/2004/04/0420_040420_earthday_2.html

"According to the 2004 Arctic Climate Impact Assessment, climate models project that local warming in Greenland will exceed 3 degrees Celsius during this century. Also, ice sheet models project that such a warming would initiate the long-term melting of the ice sheet, leading to a complete melting of the Greenland ice sheet over several millennia, resulting in a global sea level rise of about seven meters"

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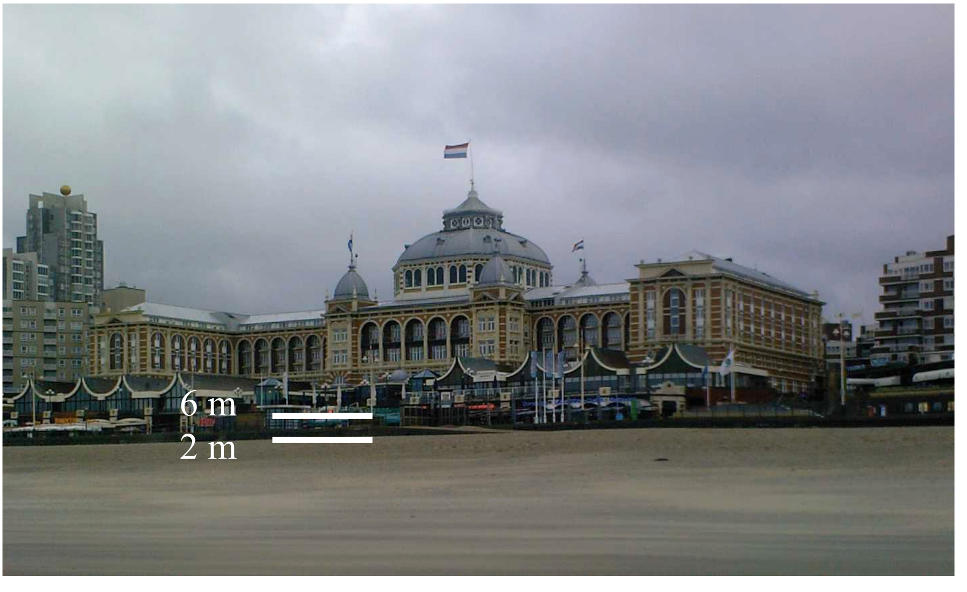
Figure 2. The pier at Scheveningen and the rising sea level

Figure 3: The Kurhaus Hotel in Scheveningen and the sea level



[7] http://en.wikipedia.org/wiki/Sea_level_rise

[8] http://www.metoffice.gov.uk/corporate/pressoffice/adcc/BookCh4Jan2006.pdf

The rise is generally expected to be 1 m in 2100 but it might also be 2 m.

The above two pictures have been taken from the beachline, in rainy December weather. I don't know much about ebb or flood. Perspective is also difficult. But I can guess at the altitudes.

☙

As an economist, I am not an expert on the field of global warming and thus I am inclined to be silent and listen to those who are. However, a lay person may still ask questions and throw an odd-ball to see how the experts react. In the following I cannot resist the temptation to consider some technical options of which I cannot judge the feasibility. Engineers will be more knowlegeable on that. Yet, the options could be aired so that others could discuss them. Rather than contacting a single engineer and let his or her opinion be decisive I think that it is better to have the ideas in print so that more engineers can consider the issues. Even when the ideas aren't feasible then they might cause new ones that are.

☙

As an economist I may observe that the issue here is not that "Holland will be flooded again for sure". The issue is one of risk, see Colignatus (2005). Risk weighs bad outcomes with their probabilities. A bad case scenario of a rise of the sea level by 6 meters and sea storms becoming more violent has a low probability. Other bad case scenario's are that your house will burn down next year or that you may die in the next five years. For such risks you might want to buy insurance. For natural disasters as flooding the insurance premium means actually taking some precautions.

Another point to note is that the world might want to reduce global emissions of greenhouse-gasses but that doesn't solve the problem of the accumulated stock of earlier emissions. Thus the risk of global warming has some momentum. When your car is racing towards a wall then it surely helps to take your foot from the gas pedal. The problem with global warming is that we haven't found a brake yet. The only thing that we can do is to create a cushion for when the wall hits us. [9]

By the time that home prices plummet in Holland, venture capitalists might buy that cheap property and try to enact some of these and other wild ideas. That might be the main point of this essay. If the seas indeed would rise by six meters, eventually, then ideas to do something about that would have to be *rather wild* indeed. Just as it would be a wild idea to try to stop global warming itself.

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[9] In common psychology it is the wall that hits us and not us driving against the wall.

2. Sea dikes

A system of dikes and dunes

Dutch soil is sand and clay and different grades of mud so that serious building materials must be imported while too large a mass will sink away. But perhaps Europe's garbage deposits can be used to provide the mass to raise the current dikes.

The system of a dike generally is that the interior merely consists of sand and clay while only the outside consists of hard stones that protect against waves and wind eroding the construction. The dike might be raised by lifting the outer layer, adding sand and clay, and putting back the outer layer. You might add 1 meter in the next ten years, 1 meter again in the next ten years, and, depending upon the seriousness of the problem, continue to 6 meters. Perhaps the sea storms will be more vicious and another meter is required. When the dike becomes too heavy for the muddy grounds to carry then you might have to replace what you already put there and include a stronger foundation.

Part of the current protection against the sea consists of dunes. These may become more vulnerable and may have to be replaced by dikes. Dutch beaches in Summer provide the joy of sun, sand and sea but perhaps the sand will go out of there.

All in all we may be speaking only about 600 kilometers of sea dikes (that is not an official figure, derives from merely looking at the map), presuming that Germany and Belgium do their part too so that we don't have to worry about the back door.

It is not clear whether the engineers say that all this would be feasible. Perhaps there are obstacles that this author is not aware of. Nevertheless the whole operation strikes one as rather costly.

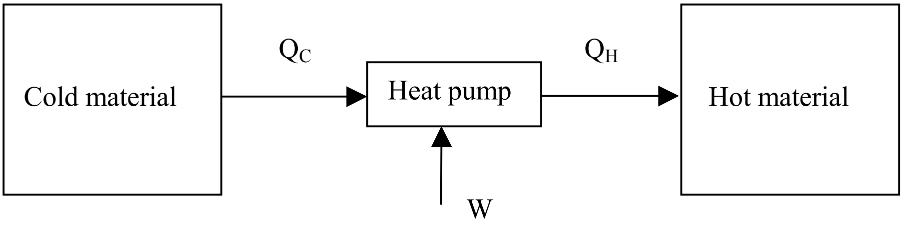
The notion of a heat pump

We are all familiar with the concept of a refrigerator or an air conditioner. They all work on the general principle that heat or cold is transferred from one place to another. The general denominator is the notion of a "heat pump".

A heat pump is “a device which applies external work to extract an amount of heat Q_C from a cold reservoir and delivers heat Q_H to a hot reservoir.” [10]

The pump itself uses energy or work W and the “coefficient of performance” then is $CP = Q_H / W$. In a more ideal set-up $Q_H = Q_C + W$ which is shown in Figure 4.

Figure 4: Diagram of the principle of a heat pump



C.R. Nave gives this example: “For example, an electric resistance heater using one kilowatt-hour of electric energy can transfer only 1 kWh of energy to heat your house at 100% efficiency. But 1 kWh of energy used in an electric heat pump could "pump" 3 kWh of energy from the cooler outside environment into your house for heating.”

Dikes of ice

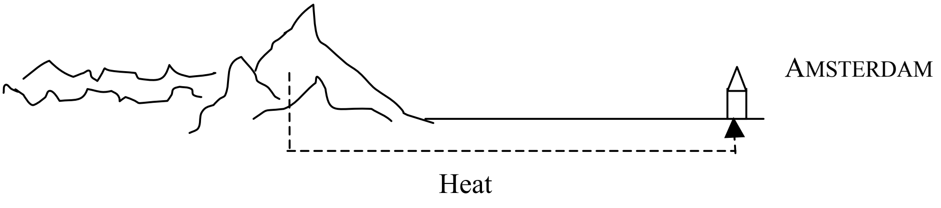
Normally one wouldn’t use ice to build dikes since it would melt away in Summer while in Winter ice would still float on water. These drawbacks however could be overcome with some added advantages:

- Freeze also the underground so that the ice on top is glued to the bottom
- Freeze a lot during Winter so that the cold storage is sufficient for Summer
- Ice is lighter than sand, clay or stone so that the dikes can be higher
- Building becomes an easy process when it suffices to let the rain fall and freeze on the dikes
- In Winter, Dutch homes need heat.

[10] Hyperphysics, C.R. Nave, Georgia State University
http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatpump.html

Holland currently wastes its resource of natural gas on heating homes and generating electricity. Apparently heat pumps are more efficient. [11] Hence the proposition becomes to use heat pumps to extract heat from the dikes of ice and so that two aims are served: homes are heated and those dikes are preserved. Figure 5 presents the general idea.

Figure 5: A winter scene in Holland 2025



The scheme implies that normal energy sources are still used, now to power the heat pumps. If heat pumps are three times more efficient then Dutch energy use for heating homes might drop to third – if all homes would be connected. There will still be emissions of greenhouse-gasses, only less than now. The cold of the dikes of ice only compensates for heat in other places but the average global temperature still rises. The dikes of ice might add a little bit to the reflection of sunlight but that effect would be marginal.

It remains an assumption that such heat pumps can be built such that the ice forming around them doesn't insulate them, such that it remains possible to extract heat from rain and sea water. It is another assumption that if such a pump breaks down, that it would still be possible to reach it and repair it, without endangering the structural strength of the dike. Undoubtedly these aspects need to be tested in practice.

A multitude of changes

While the principle is rather simple – not much different from a big refrigerator – the scale is such that we may consider a multitude of changes so that a great number of questions arise. Even assuming that it would work technically and would provide adequate protection against rising tides and possible hurricanes, there are numerous other angles to consider. The following tries to catalogue those questions into a limited number of categories.

[11] See the C.R. Nave website mentioned above.

- How much will it cost to connect all homes to the heat pipes ? Would it not be more efficient to have a small heat pump per home just extracting heat from the close environment ? Once those are in place, would there still be some use for the heat extracted from the dikes of ice ? A tentative answer is that it might be more agreeable to have all cold located in one spot such as those dikes rather than walking through Amsterdam and be cold-blasted from all sides.
- Will the weather and the sea be affected by these dikes of ice ? Will there still be some heat left in the Warm Gulfstream for Denmark and Norway ? What happens with the local fish ? A tentative answer is that those dikes might be 20 meters wide so that their effect might be only local. As the sea water might be a bit cooler then it may be observed that cold water holds more oxigen so that it might actually be better for the fish.
- What about Summer ? Could one enjoy a day at the beach while sitting on a dike of ice or swimming close to an iceberg ? A tentative answer is that some stretches along the coast might still be made by traditional dunes and dikes. If we are speaking about 600 kilometers of dikes then 5% traditional dunes and dikes still leaves 30 kilometers for traditional enjoyment. But also some of the ice might be covered in Summer with the advantage that this might preserve the cold.
- What happens to the ground water level ? Part of the rain water leaves Holland by river but another part goes underground just through the sand. Will that be blocked by the frozen ground below the dikes of ice, requiring more pumping to get it out ? A tentative answer is that this actually may work out beneficial. Currently it is the salt seawater that threatens to seep through. With a rising sea level, the outer pressure becomes even higher. The frozen ground under the dikes of ice would help to block that salt water. But it might well be true that one still needs more control of the inside water level.
- Suppose that this would preserve the existing Dutch society with its wasteful way of existence. That would also preserve the shifting of the burden to other countries such as Bangla Desh that perhaps don't have the techniques and resources to build such dikes of ice. Thus, is it wise to develop this idea ? Would it not be much better to simply just stop the emission of greenhouse-gasses ? A tentative answer is that this issue can be discussed elsewhere. This essay primarily presents some ideas. It so happens that Holland inspired those ideas, that is all, and the ideas might be applied also to other cases with adaptations to local conditions.

The threat of water is not just from the sea

Raising the sea dikes won't help much if the Rhine and Meuse rivers keep flowing at their current altitude. The sea would rush in at Rotterdam anyhow. This is the topic of the next chapter.

3. Inland dikes and inland water transport

Doing a bit more than just raising dikes

In Figure 1 the Rhine flows from right to left, from Lobith in the East to Rotterdam in the West.The difference in altitude between Lobith and and Rotterdam is about 9 meters.

When the sea level rises due to global warming then the inland dikes will have to be raised too. Many small towns have been built assuming a certain level of water and could not easily adapt to another water level. It is difficult to imagine Amsterdam or Delft with all their canals guarded by walls of 1 or 6 meters high, if it were feasible to do so, obscuring or blocking the view from the houses along the canals. It would make more sense to raise the dikes of only the major rivers – Rhine and Meuse – and thereafter control the inland water level with locks and sluices.

One possibility is to raise the dikes of these two major rives all to 9 meters, so that the difference at Rotterdam could be used to generate hydro-electric power. An alternative might be that a certain difference in altitude is required to maintain sufficient flow, especially when heavy rains cause inland flooding in Germany as well. If the sea level would rise by 6 meters then the difference in altitude might only be 3 meters.

At some points the Dutch polders may be 10 meters below sea level. Thus the difference in altitude between the polder floor and the dike top might become at least 19 meters. As said, the ground below the dikes may be rather muddy so that one would have to use a wide cross-section to carefully build up the dike's mass. An alternative is to use the freezing technique discussed above. Towns close to the current dikes who would lose their homes and properties might favour the idea to research that latter option.

While reorganizing the Rhine we might as well reorganize it in a more complete manner.

As an alternative we can imagine a flow *A* from Lobith to Rotterdam, a flow *B* from Rotterdam back to Lobith, and a flow *C* again from Lobith to Rotterdam. The advantage is that ships could sail downstream from Rotterdam to Lobith, saving the fuel from sailing upstream. Note that *B* and *C* do not have to be as wide as *A* if we let *A* also drop some water off into the sea, generating hydro-electric energy.

If the allowable difference in altitude is 3 meters then each stretch would allow for 1 meter difference. Thus the dikes (or likely concrete buffers) between these stretches would only need to be so strong (and not 19 meters again).

There are two additional advantages of this approach:

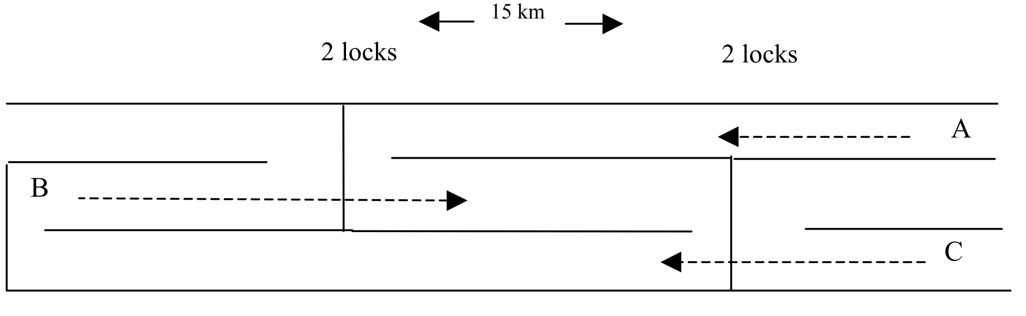
- We might add a railtrack on top on which a motor can run that can pull the ships. Ships then don't have to carry their own captain and fuel for this part of the trip.
- In case of a severe inflow of water (possibly with flooding in Germany) then we can use all three stretches to flow to sea.

Using a finer grid

Raising the dikes of the Rhine with 6 to 9 meters in Rotterdam might seem too drastic a step in short notice. It is like a building of three stories that blocks the view and that hinders connections while we are only considering risks further up the century. We can try for a smarter approach that already lays down the basic structure but that uses smaller building blocks that can be upgraded over time when needed.

Figure 6 shows how the Rhine might be transformed. Each flow might be 20 meters wide so that the total river width is 60 meters. [12] The dashed arrows now indicate the continued movement of ships, while the water flows like a "Greek ornament". The locks might be at intervals of 15 kilometers.

Figure 6: Alternative flow (dashed: ships) [13]



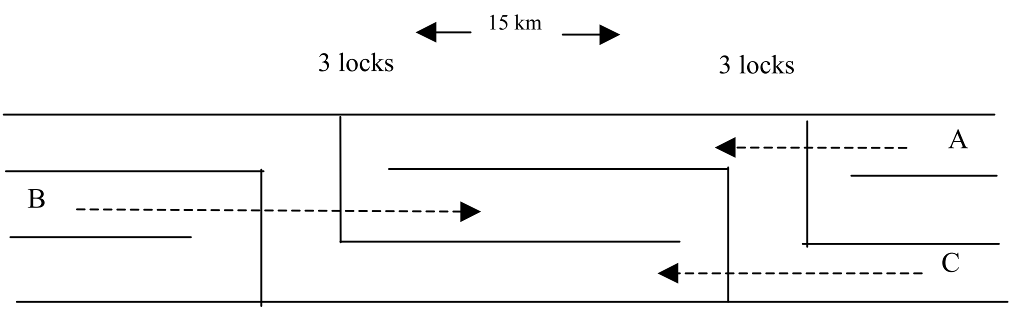
[12] Flow A might be split into one that goes to Rotterdam directly and one that uses this scheme.
[13] A water lock allows to overcome a difference in altitude by allowing water to flow into or out of the gate, with a ship lifted up or down.

The advantages of this approach are:

- The concrete separations between the flows can be much weaker.
- When the sea level rises then we can distinguish the rough work of raising the outside river dikes and the more subtle inner works. The locks and inner concrete separations could be built such that they might be raised relatively easy once the overall water level must be raised.
- Conceivably it is easier to link up this system with inland harbours and locks to connect to the inland waterways that remain at their current level.

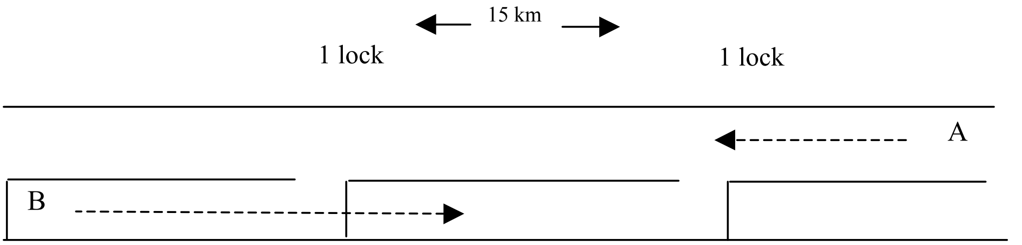
This text of 2006 did not contain the simpler Figure 6 and Figure 8 but the more complex Greek ornament of Figure 7. Where the water flow *C* returns to *A* one this would require a water tunnel so that the lock for *B* is as flat as possible.

Figure 7: Another alternative flow (dashed: ships)



A simple application is Figure 8 when the water level in stream B is at the height of the inflow and remains at that height, so that the water is basically stagnant, and the advantage is only the absence of a current. This would be the traditional application. The Rhine drops 9 m over 150 km or 6 cm per km, thus a lock each 15 km has to overcome 90 cm.

Figure 8: A simple application (dashed: ships)



Additional considerations

With the power of 1 horsepower one can transport 150 kg over the road, 500 kg by rail and 4000 kg over water. You can check this by comparing rowing a boat and trying to lift it. The European Union observes the same: [14]

> "Compared to other modes which are often confronted with congestion and capacity problems, inland waterway transport is characterised by its reliability and has a major unexploited capacity.
>
> During the past 15 years, the fleet has been modernised continuously. Wherever possible, in particular along the European river network, inland waterway transport is a competitive alternative to road and rail transport.
>
> Inland waterway transport has major assets. It is particularly effective and energy-efficient; its energy consumption per ton-kilometre of transported goods corresponds to 1/6 of the consumption on the road and to half of that of rail transport. Its noise and gaseous emissions are modest. According to recent studies, the total external costs of inland navigation (in terms of accidents, congestion, noise emissions, air pollution and other environmental impacts) are 7 times lower than those of road transport.
>
> Inland waterway transport ensures a high degree of safety, in particular when it comes to the transport of dangerous goods. Finally it contributes to the decongestion of the overloaded road network in densely populated regions."

Making an efficient system even more efficient meets the law of diminishing returns. Above reconstruction of the Rhine primarily saves the fuel from sailing upstream. Perhaps the capitalized saved costs are insufficient to warrant the investment in the required infrastructure. Adding a rail superstructure might perhaps save only marginal costs on the crews. Comparison of water and road is awkward when goods have to be overhauled again to be delivered to the final destination. The decision requires a cost-benefit analysis that considers the impact on the whole transport system and actually the whole economy.

Fuel costs would be a less relevant factor if we would be able to find energy sources that are more agreeable on the emission of greenhouse-gasses, such as heat pumps and geothermal energy.

But the potential rise of the sea level will pose a new challenge to inland water transport in Holland and the required change might be planned to make it the best reponse possible.

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[14] http://ec.europa.eu/transport/iw/overview/assets_en.htm

4. Other wild ideas

The ideas suggested above are pretty wild. They might be compared to some other wild ideas.

Professor Schuling came up with the idea to inject sulphuric acid into subsurface limestone to create gypsum (plaster), so that the layer will expand and raise the countryside. [15] It would also create carbon-dioxide but on balance it might work.

There is the suggestion of reforestation of the Sahara. Peter Warshall adds this touch: “The U.S. government has poured millions of dollars into the reforestation of the Sahara region of Africa, and I was asked to survey that country to find out how reforestation might be done effectively. Starting with the premise that governments, religions, and economies are interconnected, I realized that many of the people in this region of Africa are Moslems and their great dream is to go to Mecca, so I said to the U.S. government, "Give every family houshold a hundred trees, tell them that in 20 years if any of those trees are still alive, you will send the head of the household to Mecca, which only costs $250 and probably Saudi Arabia would pay for it anyway to encourage the practice of the Moslem religion." ” [16]

One might also build a network of pipes from Southern Europe to Nothern Europe and transport warm air or water from the South to the North. It might be more efficient to use geothermal energy (short pipes 100 meter into the earth surface) but geothermal energy would make the Earht surface hotter while the aforementioned system of pipes would redistribute the existing surface heat.

Thinking along the lines in this essay one might also consider freezing carbon-dioxide. There is already experience in pumping CO_2 back into ‘empty’ geological reservoirs where natural gas has been extracted. But an alternative is to store frozen CO_2.

It appears that CO_2 at 1 atmosphere freezes at –78.5 degrees Celsius, going directly from gas into “dry ice”. [17] This dry ice is dangerous since when it turns into gas back again then it is heavier than air, will hang around and might suffocate people. If one would look for a location to freeze carbon dioxide then

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[15] http://www.newscientist.com/article/mg18524813.900-earth-is-no-museum.html
http://www.stw.nl/NR/rdonlyres/1D1D8D39-71E6-4820-AC6C-57A1BA9D5D5D/0/Jubileumboek.pdf
http://www.kennislink.nl/web/show?id=81793
http://www.warande.net/~ublad/ubladen/28/36/09schuiling.html
[16] http://www.theharbinger.org/articles/sus_dev/wars3.html
[17] http://www.newton.dep.anl.gov/askasci/env99/env188.htm
http://www.school-for-champions.com/science/dry_ice.htm

Greenland or the South Pole might be safest. The North Pole in Winter is only -30 degrees Celsius, due to the warmer sea water below it. [18] The average surface temperature at the South Pole is -50 degrees Celsius and ranges between -21 degrees in Summer and -78 degrees in Winter. [19] An option to cool the Earth thus might be to put a nuclear plant on Antartica, extract heat from CO_2 and beam the heat to space. One would probably be a bit desperate to do that, though.

More promising might be the observation that CO_2 can actually be made liquid at higher pressures. At 7 atmospheres or 103 pounds per square inch (psi) [20] the gas may liquify already at some –30 degrees Celsius. The compressive strength of concrete is normally between 3000 and 5000 psi. [21] One might imagine concrete containers of 50 cm by 50 cm holding liquid carbon-dioxide, as part of the building material of a dike of ice. One would only do that if there are sufficient safeguards in place that the temperature within the dike would remain at –30 degrees. Otherwise the dike would explode from within.

It may not be necessary to take that risk. Another location to consider are the Alps. The temperature at the top of the Mont Blanc can be –10 degrees Celsius. If liquid carbon-dioxide can be produced as a waste product from heat extraction and packaged and transported in concrete blocks then those might be safely stored in the Alps, in a country friendly to Holland. But it all depends upon the engineers to indicate any feasibility.

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[18] http://www.arctic.noaa.gov/gallery_np_weatherdata.html
[19] http://astro.uchicago.edu/cara/vtour/pole/
[20] One atmosphere is 14.7 psi, http://www.ilpi.com/msds/ref/pressureunits.html
[21] http://www.ce.ufl.edu/activities/cdrom/civil/concrete.html

5. Conclusion

This essay highlighted two main ideas: the use of dikes of ice by using heat pumps and the use of a Greek ornament flow pattern to allow ships to sail upstream. Some other ideas may have been touched upon but these two are the main ones.

As the risk of a rising sea level increases these two ideas might become options to consider. They require known technology but on a scope not used before. This might lead to economies of scale but the application might also run into impossibilities.

Holland deserves to be flooded. The country has been oblivious to scientific advice about global warming for three decades now and these hardheaded people deserve a lesson that it would pay to be more attentive of decent manners. [22] Nevertheless, disregarding the people, this author experiences a kind of wonder and regret about the historical beauty of the old Dutch towns and landscapes. One could consider to save these so that a future generation might have time to learn how to behave decently again.

In my current position as an economist I don’t have the time and resources to research these issues but I can at least articulate the ideas. This essay has succeeded in its objective when other people would find the ideas sufficiently interesting to research them further.

It remains to observe that the organization of national decision making may not be perfect. See Colignatus (2005) for the suggestion of an Economic Supreme Court to improve the organization of national decision making. As long as there is no such Court then the uncertainty about what is a good decision is rather large. This holds also in the current issue whether these dikes of ice are constructed or not. Thus the real advancement would be in the creation of such a Court, and with such a Court we would know faster and with more certainty whether it would be useful to do more with these and other ideas.

[22] For example, the Dutch government subsidizes the growing of vegetables and flowers in glas houses heated by natural gas, depleting a natural resource, contributing to global warming, and neglecting the fact that other areas in the world provide sufficient sunlight where the same plants can be grown. If those subsidies were targetted at more meaningful applications then more jobs could have been created too.

Literature

Colignatus is the name of Thomas Cool in science. Acapulco Jones is his name in science fiction. See also http://thomascool.eu.

References given in the footnotes are not repeated here.

Central Planning Bureau (1992a), "Scanning the future", SDU, The Hague

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