Global Warming—Myth or Reality?

John Crane

That the earth's climate changes with time is unarguable. That it is currently changing seems certain. Whether it is changing as a result of human endeavors is much less certain.

The following is the first of a six-part article intended to give an overview of current thinking about global warming and to explore its highly political aspects. Most of the data and facts are from United Nations reports; some are from various newspaper and magazine articles that will be listed at the end of the last part.

Part 1: Past Climate Changes

Ice Ages

In its long history the earth has seen a series of many warming and cooling episodes. Major cooling periods have occurred about every 150 million years, with each lasting for several million years. At times the earth was much warmer than it is now, with hardly any ice at all. At other times it was much colder, with ice covering most of the planet. For the past 15 million years Arctic ice sheets have advanced into and retreated from North America and Europe again and again, with a cycle of roughly 100,000 years. The last retreat concluded about 10,000 years ago, closing the land bridge from Siberia to Alaska that had allowed the migration of the first humans to the Americas. While we await the next advance we have been experiencing a relatively short warm period, during which we came out of our caves and accomplished the entire span of human civilization.

If we consider just the past 750 thousand years, there have been nine "ice ages." That they occurred with remarkable regularity is illustrated in the accompanying graph, which indicates the extent of ice (glaciation) on the earth. Only the very highest peaks indicate anything similar to the climate we experience today—everything else is ice age—and only once, about 130,000 years ago, did the climate match today's.

If the pattern continues, we can expect to be well into another ice age within the next 10,000 years. The questions, of course, are how soon we can begin to see the effects of the cooling and whether we are already seeing it.

Some scientists maintain they have identified even smaller periods occurring about every 12,000 years with temperature drops of about 5°F, and possibly still smaller periods occurring about every 1,000 years with temperature drops of about 3°F. Some argue that we are nearing the end of one of those cooling cycles and beginning a warming cycle. We do know that about 6,000 years ago global temperatures were about 2°F warmer than today. It was a time that saw what is now the Sahara desertwith hippopotamuses and crocodiles thriving in lakes and swamps, a time that saw moist conditions in Mesopotamia and the Indus Valley aiding the development of agriculture and the beginning of humanity's

first great civilizations, and possibly a time that was the setting of the earliest stories of the Old Testament.

During the three centuries from about 1000 to 1300 Europe had warmer temperatures than now, and agriculture flourished farther north and at higher elevations than it does now. In England, for instance, wine grapes were raised 300 miles farther north than is now possible, and sheep and dairy cattle were raised by Norse settlers in what is now icebound areas of Greenland. There was a great growth of population in Europe along with a boom in cathedral building.

Then followed the so-called "little ice age," which lasted until the end of the 1800s.Temperatures averaged about 1 to 3°F lower than present, and there were extensive glacial advances in almost all alpine regions. In the late 1600s and early 1700s sea ice choked much of the North Atlantic, causing havoc with fisheries in Iceland and Scandinavia. The Norse settlers in Greenland were wiped out. In China, severe winters killed the last of the orange groves that had thrived for centuries. It gave George Washington an his men a miserable time at Valley Forge. In the 1800s it was common for New York harbor to freeze over in winter, allowing people to walk from Manhattan to Staten Island.

Beginning in about 1900, temperatures began to rise and continued to do so until 1940. They dropped from 1940 until 1975 and have been rising since then.

There are some indications that the little ice age either didn't end or is beginning again. Current wind patterns across the poles are similar to those indicated by ice core samples to have occurred at the beginning of the little ice age.

It might should be noted that temperatures in specific regions often differ from the global patterns. In Florida, for instance, the northern limits of citrus production have been pushed southward by cold winters during the same time that the northern hemisphere has experienced a warming trend.

What Causes Ice Ages

There are several theories about what causes heating and cooling cycles. Our galaxy makes one rotation every 300 million years, and one theory is that we pass through regions of interstellar dust during the rotation. One or more of several orbital factors may affect the 100,000-year cycle. The earth has an eccentricity cycle of 93,408 years—-the variation of its orbit from a circular path—which affects the planet's spin rate and increases its magnetic field, which tends to screen off high energy from the sun, thereby cooling the climate. The tilt of the earth's equatorial plane in relation to its orbital plane changes over a period of about 41,000 years. The precession cycle of the earth's rotation (like the wobble of a spinning top) is 25,920 years.

There is little doubt that in the long term plate tectonics play an important

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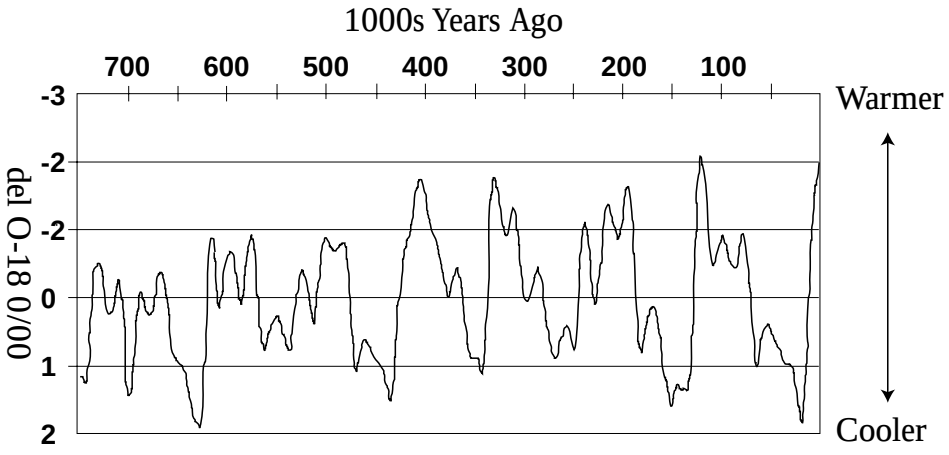

Trend of changing ice volume on the Earth

The extent of ice is estimated using changes in the amount of different isotopes of oxygen found in planktonic sea creatures. From J. Imbrie, J.D. Hays, D.G. Martinson, A. McIntyre, A.C. Mix, J.J. Morley, N.G. Pisias, W.L. Prell, and N.J. Shackleton 1984, The orbital theory of Pleistocene Climate: support from a revised chronology of the Marine del-18O record. IN (A. Berger, J. Imbrie, J. Hays, G. Kukla, and B. Saltzman, eds.) Milankovitch and Climate, Part 1, Dordrecht: Reidel Publishing Co. p.269-305.

Water Reuse and Water Conservation in The SWFWMD Manasota Basin

Jeffrey F. Payne

By viewing water reclamation on a regional basis, it is expected that a greater efficiency in water conservation can be achieved. Through funding provided by the Manasota Basin Board of SWFWMD, a water reuse system inventory was developed for the Manasota Basin, which is comprised of Manatee and Sarasota counties. The inventory summarizes existing and proposed water reuse systems in the basin; presents the offsets in groundwater and surface water withdrawals achieved through reuse; and provides a foundation for better management of water resources in the area.

Information collection on the existing and proposed reuse systems included the number of reuse systems, reuse sites, total wastewater generated, total reuse demand, and total estimated groundwater and surface water offset benefits resulting from the reuse systems. Other information included capital and operating costs, length and size of reuse transmission mains, reuse storage facilities, and alternative disposal systems for wet weather management.

Customers currently using reclaimed water within the basin include agricultural irrigation of pasture, citrus groves, flowers, and food crops, as well as nurseries and golf courses. Numerous urban customers use reclaimed water within the study area for greenspace irrigation, including parks, playgrounds, condominium complexes, and single and multi-family homes.

Manatee County

Five existing reuse systems are in operation in Manatee County: the cities of Palmetto and Bradenton, and the Manatee County Public Works Department (MCPWD), which includes three separate reuse systems. No new reuse systems are planned in the future; however, expansions of all of the existing reuse systems are planned by the year 2000. The current wastewater flow generated by the utilities practicing reuse in Manatee County is approximately 23.90 MGD. Of this amount, 8.71 MGD, or 36 percent is being reused. It is estimated that the potential current groundwater/surface water offset by existing reuse systems in Manatee County is up to 100 percent of the existing reclaimed water demand.

The total projected wastewater flow by the utilities practicing reuse in Manatee County is estimated to be 29.44 MGD by the year 2000. A total of 30.44 MGD of reclaimed water will be available by the year 2000, including 1.0 MGD of stormwater from MCPWD's proposed Frog Creek stormwater impoundment. The MCPWD has initiated a conceptual planning effort to investigate several other stormwater impoundments to supplement and blend with the reclaimed water. MCPWD is also looking at the feasibility of aquifer storage and recovery (ASR) as a means of providing cost effective seasonal storage of reclaimed water.

Of the total reclaimed water available in Manatee County—30.04 MGD—it is projected that nearly all will be reused by the year 2000. Most of the projected reuse demand is associated with MCPWD's proposed Manatee Agricultural Reuse Supply (MARS) project, which will provide reclaimed water to agricultural sites in eastern Manatee County.

The total estimated groundwater and surface water offset by proposed reuse system expansions in Manatee County is 29.61 MGD, or nearly all of the projected reclaimed water demand. Of this, 1.80 MGD is a direct offset to Lake Manatee surface water withdrawals (potable water source) as a result of MCPWD's existing and proposed urban/residential reuse program.

The proposed reuse system expansions will increase reclaimed water utilization from 36 percent of the reclaimed water available to nearly 100 percent, resulting in significant reductions in groundwater and surface water withdrawals. The reuse expansions will also reduce the amount of effluent currently being disposed of through deepwell injection and surface water discharge. The implementation of the MARS project will also provide the opportunity to implement a regional reuse system through reuse interconnections with the cities of Palmetto, Bradenton, and Sarasota.

Sarasota County

There are 12 existing reuse systems in operation within Sarasota County. There is expected to be another with the interconnection of Atlantic Utilities (recently acquired by Sarasota County Utilities) to Sarasota County Utilities' existing reuse system. The total 1996 wastewater flow generated by the municipalities and utilities currently practicing reuse in Sarasota County is approximately 15.74 MGD. Of this, 9.39 MGD, or 60 percent, is being reused. It is estimated that the current groundwater/surface water offset by existing reuse systems in Sarasota County is 8.54 MGD—91 percent of the existing reclaimed water demand.

The total projected wastewater flow by the municipalities and utilities practicing reuse in Sarasota County is estimated to be 33.6 MGD. The actual year of this projected flow is unknown due to limited information and different projection years of the various utilities in Sarasota County. Of this flow, it is projected that nearly 28.2 MGD, or 85 percent, will be reused. The total estimated groundwater/surface water offset by proposed reuse systems in Sarasota County is 20.7 MGD, or 75 percent of the projected reclaimed water demand.

Sarasota County Utilities has proposed the development of a county-wide reuse system through a Reuse Master Plan. To meet the goal of maximizing reuse in Sarasota County, it has initiated the process of acquiring small privately-owned franchised utilities and interconnecting reuse systems with major utilities/municipalities.

The objective of the master plan is to better utilize available reclaimed water and reduce groundwater and surface water demands. Currently, about 60 percent of available wastewater generated is being reused county-wide. It is estimated that this number will increase to 80 percent or greater at the completion of implementation of a county-wide reuse system. The master plan recommends integrating reuse systems with other entities, investigating and developing storage sites for reclaimed water, and coordinating with Manatee and Charlotte Counties in constructing a four-county reuse pipeline from Hillsborough

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Tampa Water Resource Recovery Project: A Water Supply with Merit

Brad Baird, Wendy Nero, Phil Waller, and Sara Katz

After years of debate and considerable legislative activity, most everyone is aware of the water resource issues facing the Tampa Bay area. Although the three-county area (Pasco, Pinellas, and Hillsborough) typically receives more than 50 inches of rainfall each year, the region has experienced water supply shortfalls and is faced with a tremendous need for additional water supplies. Contributing factors include periodic droughts, a steadily growing population, increased withdrawal of groundwater, and the need to develop rotational capacity to allow for periodic "resting" of existing supply facilities. The effects of the shortfalls in water supply have been evidenced in lower water levels in some lakes, some saltwater intrusion, and continued water use restrictions. Average day water use in the area is currently 270 million gallons. An additional 100 million gallons of water will be needed by 2005.

Although conservation has been effective in improving water-use efficiency, additional water supplies must be developed to meet the projected water demands. Alternative water supply options being considered include new wellfields, aquifer storage and recovery, brackish water and seawater desalination, and reclaimed water use for irrigation and purification for indirect potable reuse. Each alternative has merit and in some way will likely play a role in meeting the Tampa Bay area water needs.

The city of Tampa, the West Coast Regional Water Supply Authority (WCRWSA) and SWFWMD are working together on the Tampa Water Resource Recovery Project to examine the use of up to 50 MGD of purified water as a new water resource for the region.

Project Description

The Tampa Water Resource Recovery Project is a carefully planned, thoroughly monitored program to produce purified water for blending with conventional water sources. The blend would then be further treated to drinking water standards and distributed for use. The project took form in the early 1980s when Tampa's water demand projections indicated the potential for severe water shortages from increasing water demands on limited resources.

The Howard F. Curren Advanced Wastewater Treatment Plant (HFCAWTP) discharges into Hillsborough Bay a high-quality effluent meeting Grizzle-Figg requirements of 5 mg/L BOD, 5 mg/L suspended solids, and 3 mg/L total nitrogen. Currently, the HFCAWTP has a permitted average day discharge of 70 MGD and an average daily flow of 54.9 MGD, based on data from January 1995 to December 1996.

A portion of the effluent is proposed to undergo additional treatment to produce a "purified" product water that is at least as good as Tampa's current Hillsborough River raw water source. Proposed additional treatment will consist of lime treatment, filtration, granular-activated carbon, and ozone disinfection that will produce water meeting essentially all drinking water standards. A similar treatment process has been used to safely treat wastewater for indirect potable reuse at the Upper Occoquan facility in Virginia since 1978. The purified water will supplement existing water supplies in the Tampa Bypass Canal and the Hillsborough River and undergo additional treatment at the Hillsborough River Water Treatment Plant or a new regional water treatment facility prior to introduction to the drinking water system.

Plant outflows during the dry season will determine the maximum potential quantity of purified water available for augmentation of the drinking water supply. During the period of 1996 and 1997, dry season (March to June) flows were 51.1 and 51.6 MGD, respectively. The portion of flows diverted will also be dependent upon the city's current and future planned use of reclaimed water, such as the solid waste incinerator use and the South Tampa Area Reuse (STAR) Project, as well as future regulatory requirements for maintaining flows to the Hillsborough Bay.

Alternatives Being Considered

Since the early 1980s many reuse alternatives for the HFCAWTP effluent have been evaluated. The purpose of these evaluations has been to identify options to reduce potable water consumption or to augment raw water supplies. The 12 main reuse alternatives studied include:

1. Augmentation of the Hillsborough River Reservoir via the Tampa Bypass Canal
2. Augmentation of the Hillsborough River
3. Morris Bridge Groundwater Augmentation and Recharge
4. Coastal Saltwater Intrusion Barrier
5. City of Tampa Turf Irrigation
6. Industrial Water Reuse
7. Agricultural Uses East of Tampa
8. No Action Alternative
9. Area Reclamation Facilities
10. Agricultural Use in the South Hillsborough County Area
11. Some Combination of Alternatives
12. South Tampa Area Reuse

The alternative selected for further analysis in the current phase of study, as well as in previous studies, is the augmentation of the Hillsborough River Reservoir via the Tampa Bypass Canal. This alternative consists of discharging purified water into the Tampa Bypass Canal (TBC).

From the TBC, the water is repumped by the existing Harney Canal pump station to the Hillsborough River where it will mix with the native water and be stored until needed. A second option to be considered is the construction of a linear wellfield adjacent to the TBC to withdraw water from the Floridan aquifer for treatment and regional distribution. The Floridan aquifer will be recharged by the blend of purified and naturally existing water in the canal.

The first portion of the implementation plan for the project will focus on involving the public, investigating environmental effects, and evaluating siting and conveyance alternatives. The second portion will involve the preliminary design of the purified water system, economic analysis and funding scenarios,

development of interlocal agreements, and final project implementation.

Ecosystem Team Permitting

Under the provisions of state legislation created in 1995, an Ecosystem Team Permit (ETP) will be pursued. Ecosystem team permitting differs from conventional permitting and is a unique approach to environmental and regulatory review. The process enables permitting to be done in a way that entire ecosystems are protected rather than making piecemeal decisions which ultimately may not preserve individual species or their habitat. This comprehensive approach will expedite the regulatory process, reduce project costs, and result in a net benefit to the ecosystem. The regulatory agencies involved with ETP for this project include: EPA, U.S. Army Corps of Engineers, DEP, Hillsborough County Environmental Protection Commission, Florida Department of Health (Hillsborough County Health Department) and SWFWMD.

Public Involvement

Public involvement, providing opportunities for members of the public to discuss their concerns or questions with the project team, to participate in a review committee, and to attend open houses and meetings scheduled throughout the project, is an integral component of the project. The public's participation in the review process will help determine whether the project should be fully implemented, and if so, in what fashion.

The goal of the public involvement plan is to ensure that there are adequate opportunities for key stakeholders and the general public alike to be involved in the decision-making process, not to "sell" the concept of purified water. The plan includes general informational activities along with more targeted educational efforts. Following the completion of baseline research, which included stakeholder interviews, focus groups and a public survey, several different strategies were developed. A partial list of public involvement activities are as follows:

- Development of materials includes fact sheets, glossary of terms, most commonly asked questions, utility bill inserts and project brochure.
- A public working committee, made up of stakeholders from the three-county study area, will be facilitated by an independent facilitator and will result in a final committee report.
- An independent advisory panel of national experts in the areas of health, the environment, biology and engineering will be established to serve as a resource to the project team.
- A project slide show and video have been created for use as part of the project speakers bureau. Presentations will be scheduled for project spokespersons to address civic, business and industry groups (to build "word-of-mouth" awareness of the project).
- Industry events, open houses, community workshops and other special events will be scheduled throughout the study area and will focus on issues specific to the audience.
- Media outreach will be ongoing to maintain an appropriate level of awareness about the project among key media and will coincide with project milestones.
- Policy briefings, one-on-one meetings and small group meetings with elected officials and their staffs will be conducted to update them on key project milestones.

There are numerous benefits of a well planned public involvement process, including identification of stakeholder interests early in the process so that the program can be adapted, dissemination of accurate information, facilitation of a smooth regulatory process, and providing to policy makers a comprehensive picture of public interests and concerns.

Conclusion

The Tampa Water Resource Recovery Project is an important project for the Tampa Bay area with the the potential of providing a large quantity of water that can be used throughout the region. It is drought-resistant, in that it won't be influenced by seasonal variation in rainfall. It is reliable, and it uses proven technology.

Although the purification concept is innovative for this area, it has long been the basis for drinking water systems throughout the United States. With a proactive public involvement program and an assessment of environmental impacts through the Ecosystem Team Permitting process, the Tampa Water Resource Recovery Project can be accurately compared with other water supply options in the future.

References

- *Technical Memorandum 2.3–Development of Permitting Strategy and Implementation Procedures*; Montgomery Watson, January 1997.
- *Technical Memorandum 4.3–Communications Plan*; Montgomery Watson, January 1997.
- *Final Technical Memorandum 1.1–Tampa Water Resource Recovery Project Update*; Montgomery Watson, January 1997.
- *Tampa Water Resource Recovery Project Fact Sheet*; Hill and Knowlton, February 1997.

Brad Baird, of the city of Tampa, is project manager of the Tampa Water Resource Recovery Project. Wendy Nero is managing director, Hill and Knowlton. Phil Waller is a project manager with Montgomery Watson. Sara Katz is president, of Katz & Associates.

Manasota Basin *from Page 27*

County to Charlotte County. In the future, the cities of Sarasota and North Port have the potential to increase their reuse flow and improve the efficiency of the regional reuse program.

Basin Summary

There are 17 reuse systems currently in operation in the Manasota Basin study area that represent roughly 55 percent of the number of treatment facilities in the area with a design capacity of 0.1 MGD or greater. One new reuse system is planned in the future, and the majority of existing reuse systems are planned to be expanded. The 1996 wastewater flow generated by the utilities currently practicing reuse in the Manasota Basin is about 39.6 MGD. Of this amount, 18.1 MGD, or 46 percent, is being reused. It is estimated that the current groundwater/surface water offset benefit by existing reuse systems in the Manasota Basin area is 17.3 MGD, or 96 percent of the reclaimed water used.

The total projected wastewater flow by the utilities practicing reuse in the Manasota Basin is approximately 63 MGD. The actual year of this projected flow is unknown because of limited information and different projection years of various utilities in Sarasota County. Of this 63 MGD projected flow, 58.2 MGD, or 92 percent is projected to be reused, which is double the current

46 percent being reused. In addition, it is estimated that the groundwater/surface water offset by proposed reuse systems will be 50.3 MGD, or 86 percent of the reclaimed water used.

The proposed reuse systems include expansion of existing systems in Venice, Manatee County, and Sarasota. The largest proposed reuse expansion is associated with Manatee County's MARS project, which will interconnect Manatee County's three existing reuse systems and maximize reclaimed water use for agricultural irrigation and help offset current groundwater withdrawals. The MARS system will also provide the capability to implement a regional reuse system through reuse interconnections with Palmetto, Bradenton and Sarasota.

Proposed reuse system expansions involve possible regionalization of reuse systems in the Manasota Basin. This includes potential interconnection of the Manatee County, Bradenton, and Palmetto reuse systems in Manatee County, and potential interconnects between Sarasota County Utilities, Sarasota and Venice. The planned regionalization of reuse within the Manasota Basin will provide the foundation for better management of water resources within the Basin and will further water conservation efforts by preserving and offsetting up to 50 MGD of groundwater and surface water withdrawals in the future.

Jeffrey F. Payne, P.E. is with Camp Dresser & McKee Inc., Sarasota.

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role in glaciation: uplift of land masses can have a profound effect on oceanic and atmospheric circulation patterns. One of the most dramatic examples of that occurred several million years ago when the Isthmus of Panama was open and allowed the Gulf Stream to flow into the Pacific Ocean rather than to flow northward and warm the east coast of North America and western Europe as it does today.

The amount of water vapor and gases (notably carbon dioxide and methane) in the earth's atmosphere may contribute to global warming and cooling. Many processes can affect the levels of atmospheric gases, including ocean currents, volcanism, the amount and type of vegetation on the earth, and, since the beginning of the Industrial Age, human activities. But while there are certainly important relationships between ice ages and the composition of the atmosphere, many scientists are unsure whether the changes in atmosphere cause cool periods or whether cool periods cause atmospheric changes. In addition, many scientists are not totally sure that the magnitudes of past atmospheric changes were of sufficient magnitude to initiate ice ages.

Volcanoes can have dramatic short-term effects: the sulfates and other aerosols released by a major volcanic eruption can cool the planet for several years, as exemplified by the eruption of Mount Pinatubo in the Philippines in 1991, which cooled the climate by about 1°F in 1992 and again in 1993. In 1815 a huge eruption of Mount Tambora in Indonesia spewed so much ash into the atmosphere that the following year was called the "Year Without a Summer"—in June 1816 there was snow in the U.S. as far south as Mississippi. The longer term effects of volcanoes, however, are of little consequence.

The bottom line is that while there are many theories as to what causes warming and cooling cycles of the earth, there is much uncertainty as to the precise reasons for the cycles, and there is even more uncertainty when it comes to forecasting future changes in the earth's climate. ■