Overview of Alternative Space Options for Libraries and Archives

by Paul N. Banks
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What's meant by "alternative facilities"? Well, I asked myself that question too.

Buildings housing archives have ranged from

- the monumental (Fig. 1)
- to the forbidding (Fig. 2)
- to the cozy (Fig. 3)
- to the patently unsuitable (Fig. 4) and (Fig. 5)

Although NARA's Archives II at College Park is certainly a mainstream building judging by the definition of "alternative" implied by today's program, (Fig. 6) I am almost inclined to include it as an alternative facility because it is so remarkable from a preservation standpoint. Without going into specifics without stretching the definition of an alternative facility too far we have in Archives II a building, a very large and complex one at that, that essentially succeeds in achieving the preservation goals that were a central part of the original vision for it, no small achievement.

I will talk briefly about environmental standards for long-term preservation of archives, and then about three types of what might be classified as alternative archival facilities.

. . . .

Understanding of the importance of environment and buildings in preserving records is hardly new. Mesopotamian archivists four thousand years ago stacked clay tablets on shelves off of floors and away from walls to protect the vulnerable clay from damp. The Roman architect Vitruvius, in the first century BCE, described where in a house the library should be located to catch salubrious breezes and avoid excess humidity. The survival of the twelve hundred year old T'dai-ji treasure in Nara, Japan, reflects highly evolved "traditional" understanding of preserving records even in a quite humid climate. Scrolls are wrapped in fabric, which helps prevent dust and condensation, and stored in boxes made of insect-repellent wood. (Fig. 7). The boxed objects were kept continuously in a storehouse, the Shoso-in, built about 758 CE, which is a well-shaded, tile-roofed wooden structure raised about nine feet off the ground to provide maximum air circulation. All of these micro and macro measures help to keep the temperature and moisture content of the objects themselves stable. Nevertheless, many of the objects are now extremely fragile, surely in part from the continuous high humidity, and have been moved to a climate-controlled museum.

There are countless other examples from more recent centuries, in the literature and in actual buildings, of understanding the influence of building factors on the deterioration or preservation of records, but obviously only within the limits of the technology available at a given time. . . . . Since this is the annual NARA preservation conference, I am assuming that our focus is on the preservation aspects of alternative archival facilities. Another obviously crucial aspect for archives facilities is security from fire, water, and natural disasters, which we will hear about from Tom Goonan this afternoon.

It would seem to be useful to start by identifying those qualities in any archives building -- alternative or mainstream -- that contribute to the preservation of the presumably permanently valuable records that it contains. What, then, are those qualities?

In addition to the most obvious function of gross protection from the elements, we are concerned with temperature, humidity, pollutants, and light.

Having been involved in battles both within and outside the National Archives for a number years about optimum levels for these factors although unlike LBJ, I will refrain from showing you my scars I will duck talking about specific setpoints. However, there are some generalities that I think are safe to state.

There really can be no argument that materials in general last longer the lower the temperature, because that is based on the laws of matter. While we might say that materials that we want to last indefinitely should be stored at some sub-zero temperature, a number of obvious practical issues intrude, among them accessibility, cost, and risk. But clearly we should try to keep our collections as cool as feasible. (In some cases, most especially most color photographic materials, there are in fact few reasonable alternatives to very cold temperatures. Robin Siegal and Mark McCormick- Goodhart will be talking about that later today.)

The laws of matter apply also to the effects of relative humidity on materials, but the interaction is more complex. There is little argument about high relative humidity (along with high temperature) encouraging potentially devastating biological damage. Lower humidity (or more accurately, moisture content in equilibrium with lower relative humidity) slows chemical deterioration, especially the hydrolytic deterioration of materials such as acidic paper and magnetic tape binder. But mechanical properties of organic materials, and especially the behavior of composite objects, can be profoundly affected by moisture level. We conservators in all specialties have, I think, tended to overemphasize mechanical properties over chemical deterioration. In any case, Smithsonian scientists have shown, through their own work and through literature review, that in the middle range, the effects of relative humidity on mechanical properties of organic materials are probably not as great as many of us have supposed.

Donald Sebera has shown us, based on research at the National Bureau of Standards and elsewhere, (Fig 8.) the relationship of the influences of temperature and relative humidity on the deterioration of paper of low permanence. (Sebera 1994) More importantly, his method of representing their effects points up the fact these influences are continuums; that is, from a chemical standpoint the cooler and dryer the conditions are, the slower will be deteriorative chemical reactions. There are no magic numbers. We pretty much know that the same is true of light (whether visible or ultraviolet), and it seems safe to assume that it is also generally true for pollutants as well.

Jim Reilly and his associates at the Image Permanence Institute further extended our understanding of the effects of temperature and humidity in two ways. (Reilly 1995) First, they devised a way of demonstrating the cumulative effects of varying temperature and humidity on records (Fig. 9). In addition, they have done extensive laboratory work on cellulose acetate and color photographs that show the same trends, although in a somewhat more extreme way, and they have given us tools to help to quantify the effects of environment on these unstable forms of records.

When an end point can be established, such as the embrittlement of paper to the point that it must be copied to preserve its text, or the least-stable dye in a color photograph has faded by 30%, and the costs of alternatives can be estimated, the isoperm and TWPI models can be the basis for cost-benefit studies. For example, such a study was undertaken by Steve Puglia here at NARA to determine whether providing optimum environment or copying is the most cost-effective approach for preserving cellulose acetate based photographic materials. (Puglia 1995)

Norms for airborne pollutants are much more problematical (Fig.10). Because records presumably are susceptible to continuous damage from pollutants and have no recuperative powers, the levels recommended for their protection are much lower than those required for human health. These very low levels present problems with both measurement and control.

There sometimes seems to be little reflection in the literature on archives buildings of these understandings about the effects of environment on collections. Neither Sebera nor Reilly are cited in two recent monographs, one from Sweden and one from Australia, for example, and there is often little or no reference to controlling pollutants.

The strong emphasis in much of the European literature is on stability of conditions rather than on low levels of both temperature and humidity to slow deterioration. There has been some work in this country by, among others, Chandru Shahani, formerly of NARA and now at the Library of Congress, indicating enhanced deterioration of paper from cycling. (Shahani, et al., 1989) But there was also the brouhaha a couple of years ago surrounding a press release and some publications from the then Conservation Analytical Laboratory at the Smithsonian stating flatly that institutions could save millions of dollars a year without harm to their collections by allowing temperature and humidity to fluctuate over fairly wide levels. I think it is safe enough to say that stability of conditions is better so what's to disagree with, as we would say in New York, but it is not entirely clear how much life expectancy can be bought at what cost by increasing environmental stability, as opposed to allowing larger fluctuations from lower setpoints.

I will return to these points in a moment when I talk about "passive" buildings.

TYPOLOGY OF ARCHIVES BUILDINGS

A typology of alternative archives buildings, with a few examples, might be useful in this introduction to today's program. Two major types of alternative facilities that are suggested by the speakers' topics are underground and high-bay facilities, along with stand-alone cold storage vaults. I want to add a third, so-called passive buildings, which are popular in Europe. I believe that there are some interesting lessons to be learned from them.

Passive buildings

A buzzword in archives circles around the world these days seems to be passive buildings. A passive building is one that is designed to maintain reasonable environmental conditions with few or no mechanical systems.

Peoples in various severe climates have evolved building styles that provide the greatest possible comfort utilizing such measures (depending on the specific climate type) as sun screens, courtyards, elevation above grade, and wind towers. We saw a picture earlier of the Shoso-in, and systems such as this (Fig. 11) may have considerable effectiveness for human comfort, but they almost always depend in large measure on ventilation.

The three common elements of most passive buildings in the archives context seem to be massive building fabric, shading, and ventilation. (For some tropical climates, shading and ventilation alone are recommended.) Shading certainly helps control daily solar gain cycles, and massive building envelopes can help to stabilize short-term fluctuations. But ventilation bringing in untreated outside air will, by definition, bring in any humidity and pollutants that are in the ambient without specific systems to remove them (Fig. 12). This is the un-air-conditioned national archives building of a Central American country, a massive building in which, however, vehicle exhaust and smoke from cooking fires on the sidewalk is brought into the stack windows that you can see along the bottom. On the other hand, in the main example that I will talk about any internally-generated pollutants are trapped inside as we will see.

Moreover, massive structures, as effective as they may be in stabilizing short-term conditions, will over longer periods drift toward the ambient. In other words, in prolonged damp or hot periods, the interior of the building will become more humid or warmer without what are sometimes called "artificial" means of controlling conditions. There are apparently several passive archives buildings, or semi-passive ones with some mechanical equipment, in Europe that are reported to be only partly successful. One passive building that appears to be quite successful on its own terms is the Regional Archive of Schleswig-Holstein in Schleswig in northern Germany. (Christoffersen 1995) It was thoughtfully designed to meet its goals of providing relatively stable environment with little or no energy consumption. Looking at its features for a moment may be instructive.

The building has no HVAC systems aside from small heaters in the stacks for reducing relative humidity, which in the event have not been used. Climate: The range of average monthly temperature in Schleswig is 0ø to 17ø C. or 32ø to 63øF., and relative humidity 75% to 92% (Fig. 13). Massive building envelope (including interior wall adjacent to stack rooms) with specific thermal and moisture transmission properties (Fig. 14). There is no intentional ventilation: an air exchange rate of 0.05 changes per hour (which I suspect wouldn't meet code in any U.S. jurisdiction). There are also air locks into stack rooms, and the stack rooms are compartmentalized to further reduce air exchange (Fig. 15).

Extremely limited access to minimize latent and sensible loads from people and lighting, and to reduce air exchange.

Also note especially that the target RH is significantly higher than the research I mentioned earlier would indicate as desirable, and certainly higher than would be acceptable for photographic and magnetic media (Fig. 16).

The trendiness of the idea of passive buildings is exemplified by the new International Organization for Standardization (ISO) standard on storage requirements for archive and library materials, approved I might add testily over the negative vote of NARA, which recommends types of passive buildings that would be totally unsuitable in many climates outside of northern Europe.

I don't mean for an instant to underestimate the social, economic, and environmental costs of excessive energy-consuming mechanical systems anywhere on the globe, nor do I mean to minimize the difficulties of providing appropriate protection for archives in less-developed parts of the world, which may be in areas with hostile climates, high pollution levels, and limited technological infrastructure. But the unfortunate fact of the matter is that there appears to be no way to simultaneously control temperature and relative humidity and pollutants to reasonable levels without full mechanical systems. For newer and more environmentally-sensitive photographic and magnetic media, there appear to be few realistic options other than close control of the environment. This is not to say, of course, that mechanical systems and energy consumption cannot be reduced by clever use of many of the elements of passive buildings, as indeed is pretty much standard practice.

Caves

I'm going to use the term "caves" for short for the next category of alternative facility, although underground storage facilities may not really be caves. (Fig. 17 is not currently available.) They may, for example, be depleted mines in the sides of mountains, so that the repositories are actually in one sense above grade.

Below-grade facilities (whether inside a mountain or below the generally prevailing grade level) can offer both energy efficiency and highly stable internal climate with minimum mechanical equipment and energy usage.

I mentioned earlier that some alternative archival facilities seem to be based on inadequate understanding of the effects of environment on collections. A notably clear-sighted exception, based not only on understanding of the kinetics of deterioration but also on the costs of options other than providing optimum storage, is a specialized facility of the National Library of Norway for the ultimate preservation copies of Norwegian publications and for some photographic materials. It consists of chambers in a mountain just below the Arctic Circle (Fig. 18). The inherent temperature of the mountain is 8øC, or about 46øF, year around. A mechanical system is needed, however, to dehumidify the otherwise virtually 100% indoor R.H. Rolf Dahl of the Norwegian national library calls storage here "decelerated aging," a nice concept, I think. (Dahl 1992)

Closer to home and more broadly applicable, U.S. government agencies, including NARA, are beginning to use so-called caves, actually depleted limestone mines, for records storage. (Fig. 19) This is a facility outside Kansas City in which the Social Security Administration is renting space for records. At least one similar facility is being used by NARA, and I believe more are planned.

Below-grade facilities are not rare among libraries and archives. They can offer minimum external thermal loads and high environmental stability. However, since water seeks the lowest level, there is always concern about seepage or flooding, and dehumidification may be a necessity. Siting, structural design, and careful construction are crucial to making them safe for records.

A potential problem with warehouse-type underground facilities having internal truck and automobile traffic that I observed first-hand in Kansas City is pollution from the vehicle exhaust (Fig. 20). There was quite a miasma in the traffic tunnels, and some diesel exhaust odor could be smelled in the actual records storage area. Tom Benjamin will be talking later about aspects of using underground spaces for preservation storage of records.

High-bay

One kind of building that I think could be considered "alternative" in the archives context is what is known as the high-bay warehouse based on the Harvard Depository model (Fig. 21).

Basic high-bay warehouses have apparently been in use for some time in industrial applications (Fig. 22). They are predicated on thirty-foot high shelving and the use of a mobile hydraulic lift for access to the shelves. So far as I know, the grand-daddy of high-bay buildings for library and archives use is the Harvard Depository Library in Southborough, Massachusetts, about which we heard in an earlier NARA preservation conference (Fig. 23). HDL opened in 1986 as a controlled-climate site for storage of low-use materials from Harvard and other libraries. Although there were some problems initially with the mechanical equipment that have since been corrected, the Harvard facilities people accomplished what seems to me to be a brilliant piece of systems analysis, engineering, and design, which was also based on thorough understanding of the mechanisms of deterioration of records.

The HDL model, as I will call it, is based on several closely interlocking principles:

- High volume-to-area ratio of the structure, which influences construction costs
- Excellent insulation and vapor retardance
- High-density storage of primarily cellulosic materials books and documents which helps to stabilize relative humidity
- Highly automated location control, which permits storage by size (for books), high density, and efficient retrieval
- Very tight structure to reduce loss of treated air (Fig. 24)
- Office and processing areas are outside the more stringently climate controlled storage modules

In the Harvard facility, but not universally, allowing rather large seasonal temperature and humidity changes (on the basis of Isoperms, which show that deterioration of paper is more influenced by temperature than by RH), to further reduce energy costs. Setpoints are reported to be 60ø and 50% in the summer and 55ø and 35% in the winter.

HDL, like at least many of its progeny, is built in modules to which more modules can be added. The Harvard property can accommodate ten modules (of which three have been built thus far) with a total of 1.8 million linear feet of shelving. One other example of a high-bay library and archives building is the Library Storage Facility at the University of Texas in Austin Fig. 25. (In its earlier stages this was called "the warehouse," and one can see why, but I guess it was decided that that name was too inelegant). It is a purely utilitarian building, designed to maintain 55ø +/-5ø and 35% +/-3%, but otherwise quite similar to the Harvard Depository.

There are now a number of these facilities around the country based on the Harvard model, although I haven't been able to identify them all. For one thing, there seems to be very little literature on them. The New York Public Library, Columbia, and Princeton are planning a cooperative one, and we will be hearing later this morning from Doris Hamburg about one at Fort Meade for LC that is in the planning stages. An interesting paradox of this type of facility is that it provides a far better preservation environment at more reasonable cost than the main libraries, including the rare books and archives departments.

CONCLUSION

Preservation of the collections is one of the most fundamental goals of an archives building, along with security and service. One narrow definition of an archives is "the permanently valuable records" of an organization or activity. "Permanently valuable" suggests forever; forever is a long time, and in fact no record will last forever. One lesson that seems clear from some of the sources I found in doing my research for this paper is that understanding the effects of environment on records is crucial in developing a program and specifications for an archives repository that truly serves to prolong the life of the collections.

Not all the types of facilities I've mentioned may be suitable for archives repositories in the

United States context, nor in climates other than those for which they were designed. I think, though, there are useful lessons that can be learned from them about providing preservationally sound, affordable, and cost-effective archives repositories. I look forward to learning more about them today at this fourteenth annual National Archives preservation conference.

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Paul Banks established the first graduate training programs in library and archives conservation at the School of Library Service, Columbia University. He currently teaches at New York University and at the Palmer School of Library and Information Science. His principal research interests are the theory of library and archives conservation and the effects of environment on collections.

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The U.S. National Archives and Records Administration
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The National Archives building, "Archives I,"
Washington, D.C. (NARA Web site)

Image 1

Lyndon Baines Johnson Library,
Austin, Texas. (Banks)

Image 2

Franklin Delano Roosevelt Library,
Hyde Park, New York. (Banks)

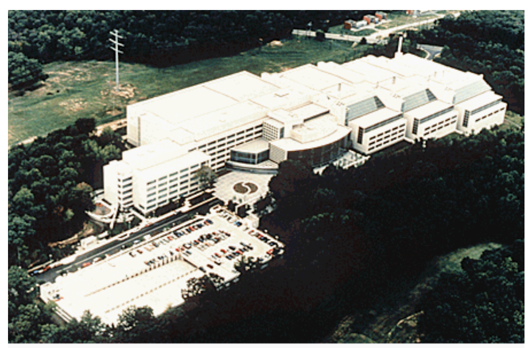
Image 3

Rensselaerville Historical Society,
Rensselaerville, New York,
in a mill house built over a mill stream. (Banks)

Image 4

National Personnel Records Center, St. Louis, Missouri,
a glass curtain wall building without air conditioning. (Banks)

Image 5

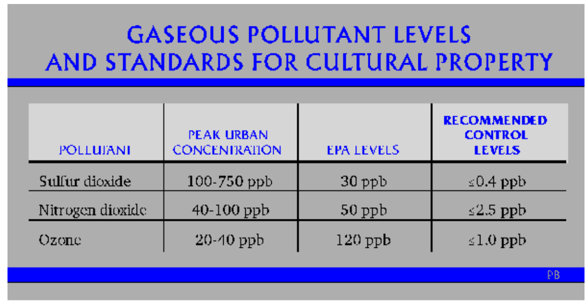


The National Archives at College Park, "Archives II,"
College Park, Maryland. (NARA Web site)

Image 6

Shoso-in, Nara, Japan

Image 7

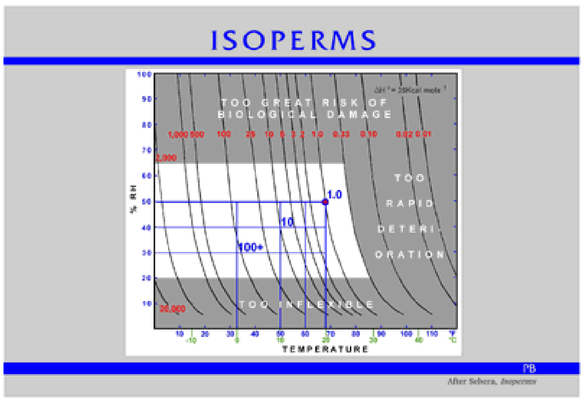


GASEOUS POLLUTANT LEVELS AND STANDARDS FOR CULTURAL PROPERTY

POLLUTANT	PEAK URBAN CONCENTRATION	EPA LEVELS	RECOMMENDED CONTROL LEVELS
Sulfur dioxide	100-750 ppb	30 ppb	≤0.4 ppb
Nitrogen dioxide	40-100 ppb	50 ppb	≤2.5 ppb
Ozone	20-40 ppb	120 ppb	≤1.0 ppb

Pollution levels for cultural property. (Banks)

Image 10

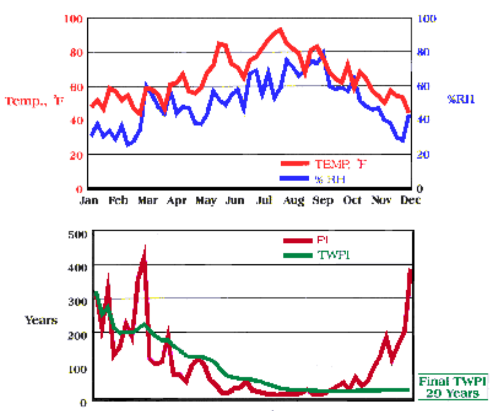


Isoperms. Courtesy of the Council on Library and Information Resources. (Sebera, 1994)

Image 8

"Natural air-conditioning." (Konya, Design Primer for Hot Climates, 1980)

Image 11

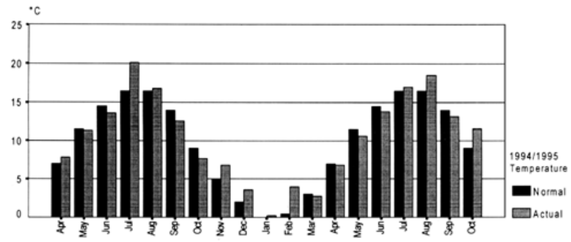


Time-weighted Preservation Index.
Courtesy of the Council on Library and Information Resources.
(Reilly, et al., 1995)

Image 9

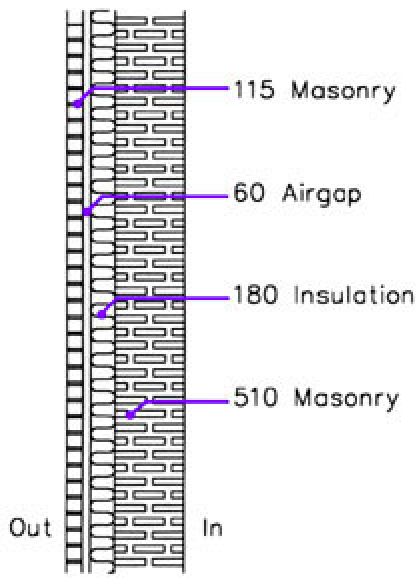
Pollutants from traffic and street activity are drawn into stacks when ventilating this national archives of a Central American country that does not have air conditioning.

Image 12



Monthly average temperature and relative humidity in Schleswig, Germany. (Christoffersen 1995)

Image 13



Structure of exterior walls, Regional Archive of Schleswig-Holstein, Schleswig, Germany. The numbers are millimeters thickness. (Christoffersen 1995)

Image 14

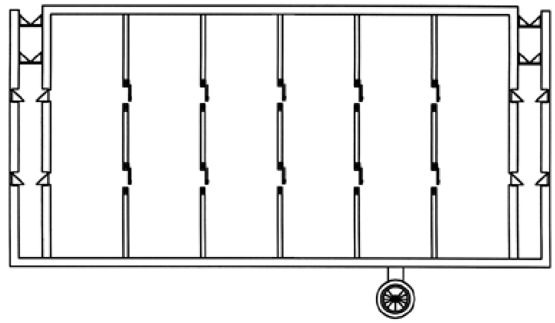
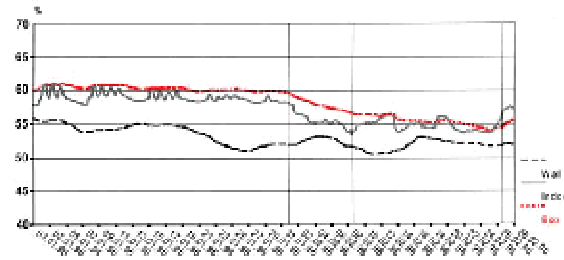
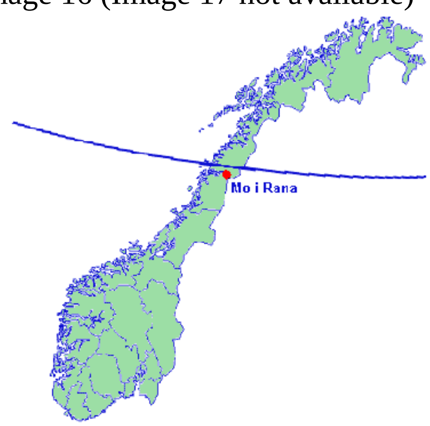

Plan of stack rooms, Regional Archive of Schleswig-Holstein, showing compartmentalization and air locks to minimize ventilation. (Christoffersen 1995)

Image 15



Internal relative humidity, Regional Archive of Schleswig-Holstein. The red line is the humidity inside a records container. (Christoffersen 1995)

Image 16 (Image 17 not available)



Location of the National Library of Norway storage facility. (National Library of Norway Web site)

Image 18

Entrance to an underground warehouse complex near Kansas City, Missouri. (Banks)

Image 19

Interior of an underground warehouse complex near Kansas City, Missouri. (Banks)

Image 20

Interior of the high-bay storage facility, Washington Regional Library Consortium, Upper Marlboro, Maryland. (Banks)

Image 21

Type of retriever used at high-bay storage facilities. (Banks)

Image 22

Exterior of the Harvard Depository Library, Southborough, Massachusetts. (Banks)

Image 23

Tightly-closing door, Washington Regional Library Consortium facility. (Banks)

Image 24

end