

DOOM BENEATH THE CITY

By MADGE MACBETH

THE city of Mexico is sinking into the land that gave it birth. It could disappear, scientists declare, not in several hundred years, but within the life of living man.

The Mexican Republic, or United States of Mexico as it is sometimes called, is our good southern neighbour once removed. Its superficial area is larger than that of Quebec, The United States forms its northern boundary, Guatemala lies to the south, the Gulf of Mexico washes the east coast and the Pacific Ocean, the west. The 6,000-mile coast line on both shores is twice as long as our southern (and undefended) boundary, and its mountains include not only peaks of unusual height but volcanoes some of which, like Paricutin, are erupting. The Rio Grande is one of the world's great rivers and Mexican history is surpassed by none in colour and romance. A comprehensive description squeezed into a brief space would present bewildering contradictions; a mountainous land, a flat land; a lush land, an arid land; a cold temperature, a tropical atmosphere. That is Mexico.

As for Mexico City, 2½ million people inhabit that modern, prosperous, rapidly-expanding capital; five times as many as would have been found there thirty years ago. Thousands of tourists swarm all over the place the year round, increasing the strain on already over-strained resources. Many go home disappointed, annoyed with the inconveniences that they themselves, by their numbers, have created. Others, appreciating the benefits of a healthy climate, the low cost of living and an ease of existence previously unknown or forgotten, remain as permanent residents. There are large colonies of people from practically every major country except Canada, making Mexico their home.

But temporary or permanent, none can fail to be impressed by this hemisphere's oldest and highest metropolis; by one of the richest and most densely-populated capitals in the world.

No one who has seen the splendour of Mexico City could contemplate its destruction without deep and painful emotion.

To understand the doom threatening this city, it is necessary to review some geographical, topographical and geological features of its remote past . . . The Valley of Mexico, nearly 8,000 feet above sea level, is a vast oval basin approximately 50 miles long and 40 wide. It is believed to be part of the floor

of an extinct volcano whose girth was encompassed by surrounding mountains. During the centuries of volcanic activity when all of these mountains erupted, thousands of tons of ash poured into the valley, forming layers of porous clay. When the tired old giants were purged of their fiery tempers, rains ate into the mountain sides and reaching the basin floor left deposits of water-impregnated sand which had been washed out of the bulk of the volcanoes. The great basin then filled slowly with clay and sand and having no outlet, most of the water remained. In fact, more water poured into the basin than soil—ten to sixteen times as much in the upper layers.

Scientists tell how in her own good time, Nature merged the water, clay and sand into a unique soil structure resembling a finely-grained sponge. Under a microscope, this soil looks like halves of egg-shells perching endlessly one on top of another. Composed of trillions of these half spheres, the soil has become as absorbent and elastic as a sponge.

But there's a limit to the amount of water that even a sponge can drink. A lake formed in the basin. It was dotted with shifting islands, formed as an engineer expressed it, "by their own debris" and looking probably like an extensive Xochimilco—a collection of island flower gardens rising from the water a few miles outside the city. From time to time, the islands touched and clung together thus increasing the area of the land. Finally, an ancient people whose origin is mystery-shrouded but who are known as Texcocans, arrived in the district and found enough solid soil to build on. They settled around the lake and on its largest island.

Later, came the Toltecs and after them, the Aztecs, both of whom made the expanding island their home. One of the Aztec emperors, Ahuizotl, must have been something of an engineer, for in order to raise the surface of the lake, he ordered all the valley streams to be diverted into Texcoco with a result that exceeded his expectations. The Aztec capital, standing where Mexico City now stands, was flooded for two years and Ahuizotl had to consider means of draining the water away! It remained for Porfirio Diaz to institute, centuries later, a drainage project which has been for many years in operation.

The hoary Colonial buildings of this ancient "City of Palaces" and its startlingly contrasted modern functional structures are a constant source of wonder and admiration. But among the 152,000 homes and other edifices there are only about a dozen having more than 10 stories. On almost any street,

you can see houses going up and houses coming down; you can see shallow excavations 4 or 5 feet deep filled with dirty brown water.

"Marshy land," the stranger presumes. "Although the lake has been drained, the soil is still soft and spongy. It won't support the weight of heavy structures."

But that doesn't make sense, because Chicago with its towering skyscrapers was raised on marshy soil. And if Chicago, why not Mexico City?

The reasons will be found in one of the most fascinating stories of architecture and its battle against Nature.

It is almost without parallel.

Architects and engineers have built a great city on the surface of a lake; a *floating city* which is unique in the world. And it is doomed to sink into a watery grave unless drastic measures are taken soon to prevent its destruction.

The lake is not exactly a *fluid* lake. It is, however, a semi-fluid body, hundreds of yards deep—at 500 feet, no firm foundation was found—whose upper levels are from 90 to 95 per cent water. The rest is composed of evenly distributed patches of soil which by some mysterious alchemy of Nature, give the lake an extraordinary rigidity. This is an established laboratory fact! Another established fact, hinted at, little understood and rarely believed by The Man in the Street, is that the thin, relatively hard crust forming the surface of the Mexican Valley, is sinking; sinking fast and taking the city of Mexico with it.

There are Aztec ruins buried far enough below the surface level to provide foundations for more modern structures. There is a church resting on the roof of a former edifice, and *both* are rapidly sinking. The magnificent Belles Artes has dropped 15 feet since its erection. The street around the Independencia Monument has fallen between 30 and 40 inches.

If this sort of relentless dragging down is going on all over the city—and it is—what does, or can, keep it above the ground, at all?

Mexican scientists, by observation, drilling and laboratory tests, have deduced a theory. Simply stated, here it is: If you saturate a sponge with water, place it in a container which it fills completely and set a weight on top of the sponge, you will find that the weight sinks only partially and slowly. Hemmed in by the walls of the container, and imprisoned by the sponge cells, the water does not readily overflow. Besides, Physics tells us that water is practically incompressible. So, unless

the pressure is out of all proportion to the resistance of the impregnated sponge, the superimposed object displaces only enough water to make room for that portion which is sinking. Presently, it reaches a point where the semi-rigid sponge is able to support its weight.

Now, the porous, water-soaked sub-soil of the Mexican Valley is our sponge. The container is the circular, close-pressing mountain wall. The pressure comes from the capital's 152,000 buildings, and this pressure has become too great. If something is not done to relieve it, Mexico City cannot survive.

Scientists have pointed out a remedy, but whether their warnings or advice will be taken must be decided by the Mexicans, themselves.

"Our capital has endured for centuries," they are only too likely to say, "and we can't agitate ourselves with these gloomy forebodings. Especially in view of all the modern methods and inventions there are to cope with just such problems."

There are three ways of erecting an edifice in this spongy soil. The oldest and easiest is to lay a normal foundation, place the structure on top of it and let it sink until it settles securely . . . more or less! In the settling process, walls and windows crack, doors sag and floors ripple like the city's dreadful pavements. Masons and carpenters in large numbers are always working to "patch" unsettled houses. Experience has proven that this first method is no good for heavy buildings. Some, like churches, lean at almost a Pisan angle; others, like the Belles Artes, not only lean but squat deeper and deeper into the oozing ground. Hundreds of tons of cement have been poured into the foundations of the Belles Artes, in the hope of solidifying the earth, but an opposite effect was achieved. The added weight simply hastened the sinking. Nor was the magnificent Tiffany glass curtain helpful. It weighs 22 metric *tons* and has to be operated by hydraulic pressure.

The second method employed by architects and builders is to "anchor" their larger structures to hard beds of sand or clay in the sub-soil by means of deep-driven piles; driven until their metal tips reach solid ground. This may be found at 160 feet or thereabouts and when found at this depth, the contractor considers himself lucky.

Formerly, 10 or 15 story buildings were not feasible, but today a larger number are being erected. They seem to perch quite contentedly on their wooden stilts, and they provide a pleasing note to Mexico's sky-line.

As a rule, there is little settling to a building raised on piles. Engineers assert, however, that there is *none at all* when the third method is adopted.

Elementary Physics teaches that the quantity of water displaced by a floating vessel, equals the weight of the vessel itself. So, with Mexico's buildings. The weight is estimated, then a similar tonnage of watery soil is excavated and the structure set in the cavity. It *floats* because the aqueous ground-displacement equals its weight, adding no extra pressure on the soil.

Simple enough in theory, isn't it, but difficult enough in practice, for the excavations fill with water, landslides flow down the walls of the excavated ground and the surface pressure of adjacent buildings *NOT* resting on piles, shifts; making a new set of problems. Yet, notwithstanding the constant battle against Nature, floating foundations have given a greater security and satisfaction than anything tried up to the present time.

It is, therefore, not too much to claim that a *floating* city of $2\frac{1}{2}$ million people is one of the wonders of the world.

The first edifice to be floated was the National Lottery; one of the city's skyscrapers. Within the hull of its foundation, there are 4 great ballast tanks. To prevent tilting caused by varying ground pressures—as new structures are raised around it—water is shifted from one tank to another, thus keeping the Lottery on an even keel. In view of this fact, then, it would seem that Mexico's troubles are over. If the floating method of building will prevent sinking, neither the engineers, architects nor the populace have anything to worry about. Even the too-frequent earthquakes are no longer the menace they used to be.

Unhappily, this comforting assumption is as fallacious as many other beliefs that people hold. Engineers and architects are still seriously alarmed because of a paradox, one of the most fantastic in the list of paradoxes . . . Mexico City is threatened with disaster because although there is too much water in the soil to provide secure foundations for her buildings, there is now scarcely enough to float them!

Water — not aqueous soil — is disappearing. With incredible rapidity. Even the recent rationing has not made an appreciable difference. Part of the blame can be laid to the sudden expansion of population and the municipal services needed to maintain it. Part of the blame can be laid to the old cracked and leaky water mains that waste vast quantities of water daily—60% of the city's supply according to one engineer's

figures. Furthermore, the indiscriminate sinking of wells, contrary to existing conservation regulations, and the generally careless and extravagant use of water, does not help the serious situation.

From nearly 3,000 wells, water is pumped for the city's use. That's bad enough, but a worse condition prevails. If a well goes dry—or threatens to go dry—many a property owner (unlawfully) sinks another. By this means, he escapes the inconvenience of municipal rationing and ensures himself a plentiful supply of water. In addition to the wells unlawfully sunk, there are those for which permits must be given in dozens of new developments that surround Mexico City.

Nothing is inexhaustible, but it is hard to convince Mexicans that the amount of water they are draining away is not nearly replaced by underground currents and rain. In other words, the sponge, lightly contained in its receptacle, is being deprived of the necessary fluid-content to hold the superstructure; and the result will soon be nothing but a squashy substance that will support no weight, at all.

Mexico will drown—in earth that at the same time is too wet and too dry!

In spite of warnings in the press and elsewhere, few Mexicans are willing to confront squarely this grim and fantastic prospect. They know their soil is swampy, that relentlessly it has sucked down cities built before their own. All of this is part of their legendary history; as familiar as the tales of ancient gods, as natural as the shining of the sun and moon. The soil has always been saturated, they say, and if buildings sank it was because engineers were unable to cope with existing conditions. Today, modern methods and inventions will find a way to solve their problem. As to what the scientists advise—laying new water mains would mean digging up the entire city, requiring years of labour and a fabulous amount of money. No less costly would be the alternative; constructing a new water works system and piping water into the city, possibly from the Lerma River.

"Mexicans," one engineer has stated, "are not enthusiastic about long-term measures. 'Prosperity in our time,' is their guiding slogan."

They won't or can't picture the horrors that may happen within the span of living men, unless steps are taken to prevent them. They won't or can't realize what this drying and shrinking of the sub-soil will do to their city; nor will they contem-

plate the awful results from any dislocation of the municipal sewage system, when refuse backs up and spreads pestilence over the tight-packed capital. They refuse to imagine a Mexico without light, heat or water even for street cleaning and fire-fighting purposes.

All of which is only part of the grim picture.

If present conditions continue unchecked Mexico is doomed to become a place of death and desolation. We have the scientists' word for it. Just as Nature reclaims her jungle, erasing all evidence of man's sweat and toil, so this great and splendid metropolis will be reclaimed, and like the Aztec's Tenochtitlan, it will exist for future generations merely as a few pages in historical volumes.