With the independence of the American colonies, Africa became the center of the European attention.

For an organized and scientific occupation of those countries, several expeditions were carried out and institutions especially devoted to African studies were created in many European countries.
The Portuguese Commission of Cartography (PCC) was created at the 19th April 1883 to elaborate and publish the cartography of the Portuguese colonies as well as any other studies related to them.

At the Berlin Conference 14 European countries discussed and sketched the new map of Africa supported by the “Principle of Effectivity” which supposed the geographical knowledge of the territory, the existence of a reliable cartography and the definition of its boundaries.

To provide the necessary accuracy it’s indispensable a geodetic coverage of this territories.

For this purpose the PCC created temporary geodetic Missions.

Year after year, those missions, covered geodetically the Portuguese overseas countries contributing to an accurate cartography.
Mozambique was the first territory being object of geodetic works to cartographic and cadastral needs.

For that, was created the Geodetic Mission of Eastern Africa (1907-1910) - MGAO

In 4 campaigns including 26 months of fieldwork this mission, directed by the Admiral Gago Coutinho established a triangulation chain, with 2 bases and 2 astronomical stations, covering Mozambique coast from the south to Bazaruto's lighthouse.

Gago Coutinho was a famous admiral of the Portuguese navy. He’s activity can be divided in 4 main areas:

- navy
- geographical works
- aerial navigation
- nautical history and history of the Portuguese discoveries

Gago Coutinho together with Sacadura Cabral were the first to cross the south atlantic ocean by air from Lisbon (Portugal) to Rio de Janeiro (Brazil) using navigation tables especially adapted for this purpose and a sextant of his own invention.
Gago Coutinho considered himself mostly a colonial geographer, since from 1898 and for 20 years, he lived in the African backwoods, sleeping in camping tents, working for boundaries demarcations and geodetic triangulations in Timor, Mozambique, Angola and S. Tomé.

A precise surveyor, he used his experience from the navy in the field operations and adapted some methodologies and instruments to the difficulties of the field work in Africa.

During his work, all the operations contributing to the geodetic covering of one country were exhaustively described in several reports that, later on, served as a guide to other geographers.

<table>
<thead>
<tr>
<th>Year</th>
<th>Role</th>
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<tr>
<td>1898</td>
<td>Delegate for the demarcation of Timor frontier</td>
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<td>1900</td>
<td>Delegate for the demarcation of Zambeze frontier</td>
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<td>1901</td>
<td>Delegate for the demarcation of North Angola frontier</td>
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<td>1904</td>
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<td>1907</td>
<td>Chief of the geodetic mission in eastern Africa</td>
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<td>1912</td>
<td>Delegate for the demarcation of Barotze frontier</td>
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<tr>
<td>1915</td>
<td>Chief of the geodetic mission of S. Tomé and Príncipe</td>
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Recognition
Measurements of azimuthal and zenithal angles
Measure of baselines
Astronomical observations
Recognition

Using a compass and a pedometer the team, travel by foot, with a local guide, through the zone to map on, to choose the local to built the benchmarks, that will define the triangulation chain, if possible on the top of the mounts.

In plane ground that work was so much more difficult that Gago Coutinho said “it was necessary to use techniques similar to navigation like to set a course with the compass,… , recognise land and make observations with the sextant at the top of the trees, to sound,…, to find the most highest and suitable point”.

The triangulation network consists in a sequence of triangles, forming geometric figures, carefully chosen in order to decrease the influence of the observations errors and to allow checking the results.
The triangulation network established by the MGAO was defined by 83 benchmarks covering an area of 40000 Km². The distance between them depends on the topography and accuracy standards, but usually was 30 km.

To guarantee the visibility they were signalized with wood, metal or bright signs like *heliums (day)* or *projectors (night)*.

Sometimes, due to existent obstacles or the curvature of the earth, the measurements were done at the top of wood towers to assure inter-visibility.
The azimuthal and zenithal angles of the triangles were measured with theodolites made by Salmoiraghi under specifications of Gago Coutinho to adapt it to the specific conditions in Africa.

Gago Coutinho wanted a high precision theodolite with special characteristics not found yet in any catalogue bringing together the best of those used in Europe and United States and the Repsold’s used in Portugal and South Africa.

**Brief history:**

In 1909 the Colonial Office of Portugal ordered to Filotécnica Salmoiraghi to build 4 theodolites under specifications of Gago Coutinho.

To provide the highest accuracy was required a covered horizontal circle, ..., and scales engraved in platinum to avoid the oxidation of the clima in Africa.

During the 1st field campaign Gago Coutinho noticed that the instrument was far from ideal being its principal defects the ocular thumbscrew and the circles, at the time very difficult if not impossible to engrave accurately.

Some improvements made them operational being used in the São Tomé and Príncipe geodetical mission (1915-1917), also directed by Gago Coutinho, and the first Cape Verde geographical mission (1918-1921).
To scale the geodetic network were measured, every 200 km, lines about 10 km called baselines.

For 6 decades in those measures were used invar wires with 8, 24 the most used or 48 m.

Gago Coutinho was the first Portuguese surveyor using invar wires, precisely in this geodetic mission.

For a long time he study hardly this equipment concluding that after 10 years, the invar wires reach its final lengthening of a third of a millimetre. Using the appropriate procedures it was possible an accuracy of 1/1000000.

The MGAO measured 2 baselines: Manhiça (12km) and Inhambane (8 km).
A requisite for a baseline is to have a plane ground without obstacles where several tripods are placed each 24 m.

A special tripod supports the wires which tension is regulated by a 10 kg weight.

In a special graduate reference - reglette - the field operator reads the values to sum or deduct to the 24 meters. And so on till covering the baseline length.
In the first years, geodetic and cartographic survey were made simultaneously. With a plane table and an alidad the hills, valleys, courses of rivers, villages were drawn in a cartographic document.

The alidad’s observations were completed by telemeters (distances) and barometers (heights) measurements. The toponymy was collected in the villages.
The work of the MGAO was continued by the Geographical Mission of Mozambique created in 1932.

This first work was very relevant for the progress of a scientific cartography and contributed, along with the later missions, for the setting up of a geodetically covering of all the Portuguese overseas colonies as well for the production of a modern cartography still in use nowadays.