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Weights and measures: The Greek efforts to integrate the metric system

(1) Introduction

Even if the metric system did not become initially acceptable with enthusiasm, its adoption from other nations began to increase regularly after its obligatory use in France in 1840. To the dues 1860 became obvious the need for more precise and of course determined units, because of the requirements created by the new scientific discoveries. This became possible with the Meter Convention in 1875, an international agreement in which participated 17 countries, while up to 1900 35 nations have accepted officially the metric system. This convention has determined with precision the units and the mechanisms for the constitution and adoption of further determinations in the metric system. In the countries of Europe the complete establishment of the Metric system took place through different conditions and in different periods.

Our presentation will focus on the situation in Greece and will examine the evolution from the ancient Greek weights and measures to the final and total acceptance of the metric system in 1959. We will examine the use of other metric systems during the Antiquity, the Roman, Byzantine and Ottoman period and we will focus on the political decisions and laws from 1836, via 1920 to 1959. We will study the Royal Decree No 56 of 1836 “*On Weights and Measures*” which reflects the existence of an agricultural society, the Law 2526 of 1920 “*On Weights and Measures*” which reflects the industrial and scientific evolution in the context of the Greek society and the Legislative Decree 3957 of 1959 “*On the Introduction in Greece of the International Metric System*” which shows the total acceptance of the Metric System.

(2) Ancient Greek, Roman and Byzantine weights

Before the establishment of currency (7th century BC) the invention of balance facilitated the transactions ensuring the control of weight of merchandises and mainly the precious metals, that were not independent from their value. The weights or *zygia*, as elements of balance compensated equal weight objects, merchandises, metals or even currencies. The weight (*stathmion*) and the relation were from each other determined depending on the weight (*stathmitiko*) system of various populations or cities-states, which prevailed a concrete time period. Babylonians have used the sexagesimal arithmetic system for and had separated the hour in 60 minutes and a minute in 60 seconds. The same division existed for the measures of surface and capacity and same thoughtful it appears reflects also the structure of the weight (*stathmitiko*) system. Thus talent was the bigger unit of weight and was divided in 60 parts, called *mnes*, and each *mna* in 60 sequel or *siklous*. The Phoenicians used as particular unit the sequel, without accepting the Babylonian sexagesimal system in its entirety. For them *mna* established the division in 50 and no in 60. The Greeks shaped their own numerical systems based on Babylonians and Phoenicians that they knew through the commercial transactions.

(2.1) Ancient Greek weights

The ancient Greek weight (*stathmitiko*) system was independent from the weight of units, was simple in structure and included mainly 4 subdivisions: the talent, the *mna*, the drachma and the obol. The talent had 60 *mnes*, each *mna* 50 staters, hence 100 drachmas and the drachma 6 obols. The stater was double the drachma.

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|----------------|--------|-------|---|---|
| Talent | 1 | | | |
| Mna | 60 | 1 | | |
| Stater | 3.000 | 50 | | |
| Drachma | 6.000 | 100 | 1 | |
| Obol | 36.000 | 1.200 | 6 | 1 |

The weights units had multiples (dimnoun, tetramnoun, distatiron etc.) and subdivisions (imimnaion, imistatiron, imitrtion etc.). The inscriptions that declared the weight accompanied usually certain characteristic symbols, frequently in use as symbols of currencies of a city and a season. For example the turtle for the Aeginean weights (aiginitika stathmia) and currencies, the owe (glayka), the amphora and the wheel for Athenian.¹ The symbols had direct relation with the subdivisions and they represented certain unit and concrete weight facilitating thus the commercial transactions after the representations distinguished from far, more easily than the signs that accompanied it. Most weights (stathmia) were flat and made from lead. The copper made was more rare and were conical and had in the upper part their aperture for suspension.

(2.2) Roman and Byzantine Weights

Main weight (stathmitiki) unit for Romans was Libra that had 12 ounces. During the period of the Roman empire the Greek weight system with all its changes, was joined with the Roman in which was incorporated the Attic drachma, equal with the 1/96 of the libra that corresponded in Rome with the dinar, as well as the 1/6 of drachma, the obol. For the transfer of Greco-Roman system of measurements in the Byzantium, important were the reforms of the Emperor Constantine. He has made these reforms in order to maintain the stability that had been disturbed during the years of his predecessors. From metrological point of view the Byzantine weights (stathmia), continue the Roman arithmetic system (based on number 12) of weight in which the basic unit was the liter with main subdivisions the ounce and the solidus or currency according to the relation: 1 liter = 12 ounces = 72 solidos or Nomismata.

The indication of weight was shaped in the upper surface of the weight (stathmion) with incision and was no infrequent to be covered by inset silver lamina. The cross that often constituted one characteristic trait of Byzantine weights was attributed with the same way and many times was found with the indication of weight under the triumphant arc or in the hoop, all symbols of the new religion. In the official government owned weights that were named exagia were represented forms of Saints or emperors of the period. Most of weights of the Byzantine period were flat, quadrilateral or polygonal but also round, plate or exalt on the sides, while Roman were spheroids with broken away parallel surfaces. The weight of libra or (litras) was calculated in 327,4 grams.

(3) The situation of weights and measures in the Hellenic space during the period of the Constitution

During the Turkish domination in Greece, around the beginnings of 19th century, are used officially the Ottoman measures and weights [stathma] and at the same time many units from varied origins. Metric terms from ancient Greek and roman period continue to be used mainly for the statement of quantitative approaching terms, while Byzantine terms correspond many times with measures for practical use. Important number of metric terms emanates from other populations (Venetian, English) survives in certain regions (Eptanisa, Crete, Dodekanisa, Cyprus), which have been possessed. Thus as it happens also all over Europe, before the application of the Metric system, the Greek traditional measures and weights presented as a multifunctional mosaic with hundreds of units and a limited scope: it was also connected with a place, with a type of thing and with a profession. Certain measures are used with different value from region to region. At the same time, it was not infrequent to be used in the same place different units for the measurement of the same magnitude.

When we were reported to the traditional units of measurement we should not give to the term unit the content that it has in the modern Metrology. In reality, an official definition or a model of reference

¹ *Μέτρα. Σταθμά. Πρότυπα. Χθες & Σήμερα*. Υ.Β.Ε.Τ. Γενική Γραμματεία Έρευνας & Τεχνολογίας, Athens (1987), p. 32.

that is imposed by the Law and the force of power characterizes a modern unit of measurement. In other countries of Europe, before the diffusion of the Metric system and in the huge variety of measures and weights that prevailed, it was not infrequent to find one weight model, model containers and model measures, that had been manufactured by the local sovereign and their utilization had acquired the force of the law. Such cases we meet also in the Hellenic space, however they existed measures, which were checked by a certain official authority (Ottoman state, elders [Dimogerontia], monastery).²

(3.1) Measures of length

In the Hellenic space, during the Ottoman domination, but also after the constitution of the Greek state, they were used, at the same time to the official Ottoman measures (as the forearm) mainly units that were based on the human body, as finger, inch, brace, elbow etc.

This situation concerns magnitudes in approach and no strictly determined measures, that were in effect during many centuries and their echo reaches us up today. With the royal decree of 1836, becomes an effort for introducing the French Metric system in Greece. This period was determined as unit of length the meter, that is subdivided in 10 palms, 100 digits and 1000 lines, while simultaneously was mentioned the difference of the new unit to the small forearm of Istanbul (0,648 meters), known as endeze and the big forearm known as arsin (0,669 meters). Apart those two forearms (without however legal model) existed the known as Meimar Zire, tectonic forearm, that was used by the builders, carpenters and surveyors of fields and amounted to 0,75 meters. In this period we can also see the use of other units for the calculation of distances, as the mile, league in parallel with the empiric, traditional ways, as the hour, as long as it reaches the eye etc.³

(3.2) Measures of surface

The measurement of the ground, as surface - area, became with empiric ways. The area of a field for example, was determined from the quantity of the seed that required in order to be seeded, the required work for his culture by the person or the plow of the animals. In this period we can mark the existence of the hectare, which was used mainly for the determination of surfaces from official bodies (public grounds and buildings). The hectare, that its value differed from region to region, oscillated between 900 and 2.500 square meters. The stabilization in 1.000 square meters will become progressively also with an argon rhythm. In Venetian domination regions were in use some foreign units as the plain (campo), the Quarta, the zapada etc..

(3.3) Measures of weight

The oka (1.280 grams) as a unit of weight was used in the Hellenic space, during the Ottoman domination and after the constitution of the free Greek state until 1959, when it was replaced by the kilogram. It was presented as the most constant and widespread unit of measurement. It was subdivided in 400 dramia. Multiples and submultiples were used locally also with various values depending on the merchandise that was weighted. Multiples of oka were for example the kantari (44 okades), that was used up to recently in the Greek space, the tseki (176 okades in Istanbul and 136 in Thessaloniki) etc. Submultiples of oka as the michtali, the drami etc., were used mainly for the weighing of precious metals and pharmaceutical species.

(3.4) Measures of capacity

In generally speaking the measures of capacity attribute in approach the weight of the kind that measures. Certain from the containers that are used as measures bring the seal of some authority, government owned or ecclesiastical or local, as for example the concave, the mikoilo (half), the tenth and their production was based on some model, which was looked after by the community, in the monastery or in the context of a permitted laboratory. These objects were unstamped and they were traditionally

² *Ibid.* p. 36

³ *Το Μετρικόν Σύστημα και η εισαγωγή αυτού εις την Ελλάδα*, Athens, Γεωγραφικής Υπηρεσίας Στρατού, (1937), p. 3

used with some looseness. For example, the difference of wheat in concave is two roughly okads when the container was paid up to (cheili, kofto, riglo) by what has been overpaid (koumoulo, souroto).

(3.4.1) Solids

With oka as base were shaped in Greek space various measures of capacity with various names. The bigger distribution had the concave, with value between 18–25 okads. There were mainly wooden or metal containers, with capacity between 18–25 okads with various names: batselli in Eptanisa and Peloponnisos, gkamprani in Thessaly, drimoni in Peloponnisos, tank in Etoloakarnania and Naupaktia, kauki in Evia, kozaki in Pontos, kouveli in Thessaly, Epiros, Evrytania and West Mani, loutseki in Thessaly, mouzouri in Creta, pinaki in Ikaria and Epiros, stampoli in Thessaly, tampoutsia in Cyprus. Bigger variety presents the submultiples of the concave with capacity between 10–12 okads. We can say that were also used measures of capacity 3, 6, 8 okads that is to say 1/8, 1/4, 1/3 of the concave.

(3.4.2) Liquids

For the measurement of liquids, apart from oka and its submultiples, they were used a variety of objects of containers that their particular size established them as measures during many centuries, without being stamped from the authorities. Most had local use (gastera, kouroupi, krentiri, kourellos, mistato, nempotis, sekio, pinta) or wider (kartaroli, kartoutso, gallon, xestis, paliatsa) and only two were in use in the entire Hellenic space (liter and meter).

(4) Weight instruments

In parallel with the instruments for the determination of weight were in use instruments which were manufactured or in government owned laboratories and were channeled in the market or in local laboratories, as in Kozani, Yannena, Heraklio, Rethimno etc. and were stamped by the responsible authorities that practiced the control.

These instruments were simple mechanisms, supported in the balance of an object to a concrete weight, expressed by the weights. These are: 1) scales with two equal arms. They are table or made dependent (portable or not) with capacity that oscillates from few dramia up to okads, depending on their use (pharmacy balance, grocery balance etc.) 2) scales with unequal arms. In this category were included steelyard and balances. 3) Newer balances, emanating usually from English factories, known as balances of tendency (various steelyards). 4) The automatic balances, which were based on the modern technological data.

(5) The Introduction of the Metric System in Greece: the efforts of the state ⁴

The introduction of the Metric System was realized finally in Greece in 1959. The efforts of the Greek state to import the decimal Metric System had begun 120 years earlier, from the period of Othon. The confrontation of untidiness that characterized the measures and the weights in released territories was one of the first objectives of the newly established Greek state. The unification of various local ways of measurement constitutes part of the process for political and national unification. Beyond its lawful intervention to the commercial transactions, the Greek state, as the other states of Europe, tried with this way to impose the guardianship and its organization in various areas, which were in relative autonomy, as geographic regions, or for social teams, or even for professional communities. The course to the unification of the measurement system in Greece was realized with big difficulties, because of the resistance that creates the traditional use and the different private interests. This course reflects the progressive infiltration and imposition of the state in the Greek society. Needed more than one century in order to begin all Greeks to measure magnitudes with the same way.

(5.1) Royal Decree Number 56 (1836) On Weights and Measures

The Royal Decree number 56 of 1836 ⁵ *On Weights and Measures* constitutes the first essential effort for unification of the metric system in Greece. In the first article of the decree was reported, “the

⁴ Θ. Κρητικός. Το επιστημονικό ενδιαφέρον για την επίσημη καθιέρωση του μετρικού συστήματος στην Ελλάδα, *Νεύσις*, Vol. 4, Nefeli, Athens, (1996), p. 129–178

system of weights and measures of the Kingdom will be metric. The base of this is the French meter, which is named forearm...”. Apart of the meter (royal forearm), the Decree 56 fixed also other new royal units that maintained old names: the stage-stadio to kilometer, the drachma to gram, the liter to cubic decimeter, the kilo to 100 liters.

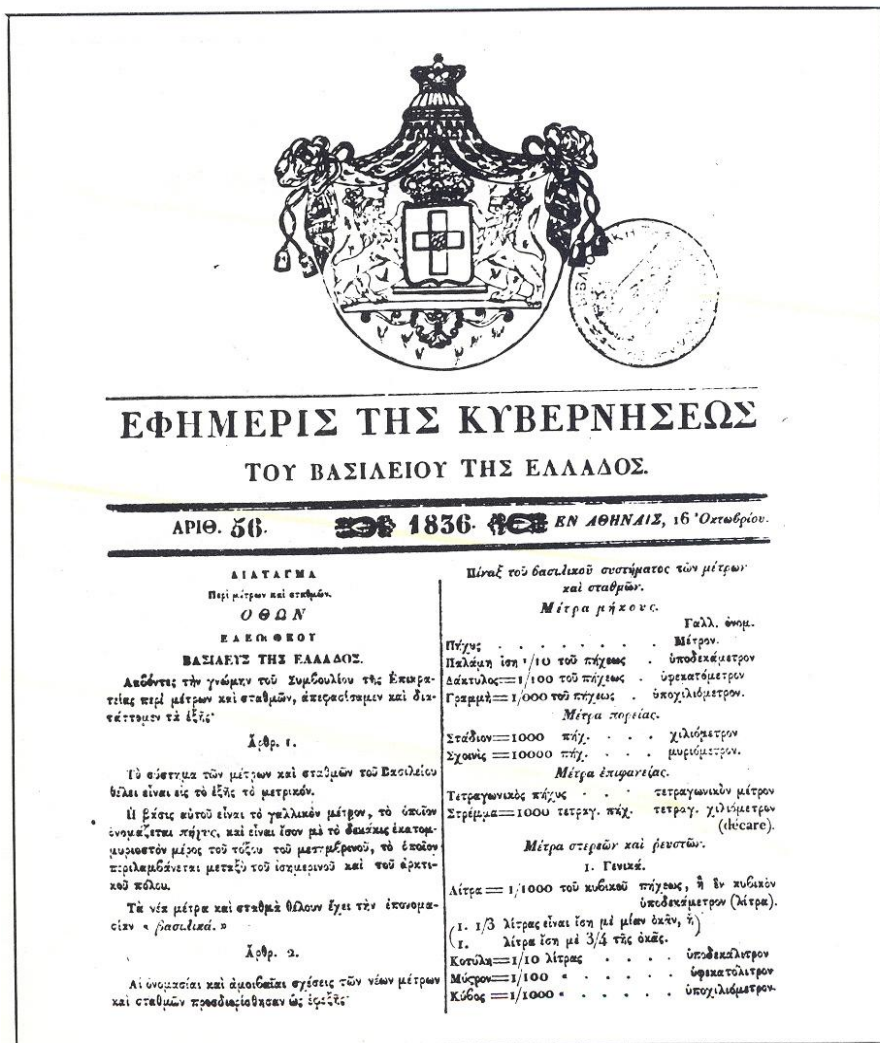


Figure 1. Royal Decree number 56 (1836)

We can mark that the main unit of weight here was not the kilogram, but the mna, which weigh 1.500 grams. The royal hectare was determined in 1000 square meters. The state could not however impose their application and overcome the reactions to these innovations. The use of the new units was limited in certain official documents or even in activities that were checked immediately by the state, as the regulating design as well as the statutes for the cities.

(5.2) Law 2526 (1920) On Weights and Measures

With the foundation of the International Office of Measures and Weights (1889), the Metric system became international. The article 1 of the law 2526 of 1920⁶ reports: “Become effective at all the state the International System of Measures and Weights”. While the content of Royal Decree of 1836 reflect a rural society, in the Law of 1920 were

⁵ Εφημερίδα της Κυβερνήσεως, No 56, 16 October 1836, p. 288–291.

⁶ Εφημερίδα της Κυβερνήσεως, Vol. 1, p. 2257–2261 and «Περί Εφαρμογῆς τῶν διατάξεων τῶν ἀρθρῶν 21–26 τοῦ νόμου 2526 περὶ μέτρων καὶ σταθμῶν» in the Εφημερίδα της Κυβερνήσεως, 22 October 1920, No 245.

reflected the existence of a group of “industrial and commercial measures and weights [stathma]”. During the time interval that separates the two statutes, the world of measurements has changed. While the royal Decree 1836 was reported in traditional sizes (length, surface, weight, volume of solids and liquids), in the law of 1920 we can see the presentation of units that correspond to the kilogram, we can also see the legalization of the time unit (the second), of the electricity units (ohm and ampere), of the temperature unit (Celsius degree) and of the unit of luminous intensity. But also this time the state did not have the necessary force in order to impose the full implementation of the law.

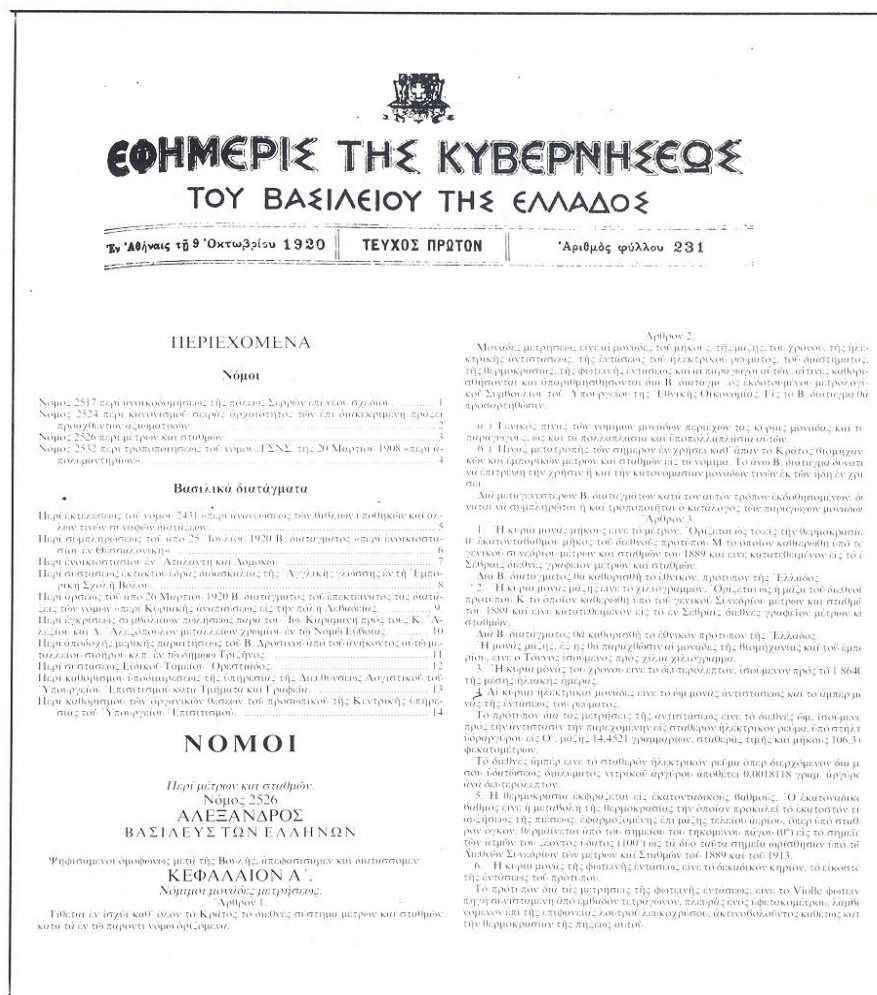


Figure 2. Law 2526 (1920)

The use of the meter expanded, but the kilogram did not achieve to displace the oka in the daily measurements.

(5.3) Legislative Decree 3957 (1959) On the Introduction in Greece of the International Metric System

With this decree was finalized the predominance of Metric system in Greece. The decree but also the administrative regulations that accompany it, gave accent in the obligatory utilization of the meter, the square meter and the kilogram. If somebody excludes the definition of units (it was modernized in 1983) and certain additional annexes, the Decree of 1959 regulates until today the arrangement of measures and weights in Greece.⁷

⁷ Legislative Decree 3957 published in the *Εφημερίδα της Κυβερνήσεως*, 30 June 1959, No 131.

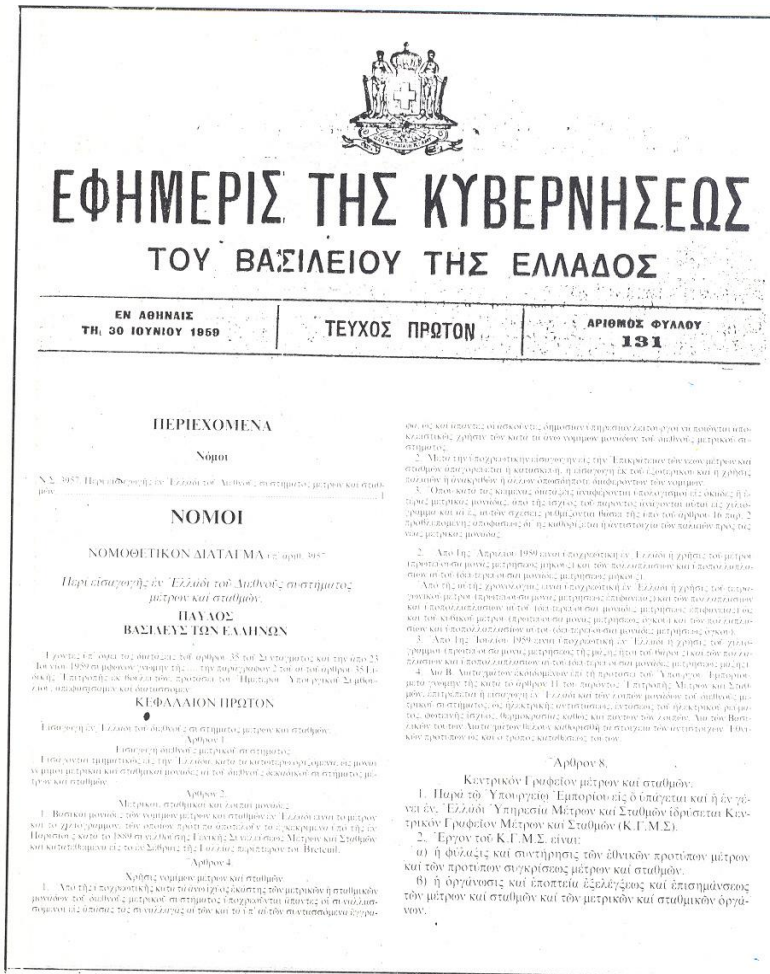


Figure 3. Legislative Decree 3957 (1959)

The national models of meter and kilogram remain those fixed by the Decree of 1959, in spite of the fact that the official definition of the meter changed in 1983.

In Greece the complete establishment of the Metric system took place the 1st April of 1959 when it was replaced the unit of weight oka, from the kilogram (kilo). The oka was subdivided in 400 dramia, while oka was amounted on 1282 grams.

(5.4) The Application of the Legislative Decree of 1959

The ministry of Trade publishes in 1959 and in 1960 many circulars and decisions with regard to the application of the law 3957. Most of them concern the replacement of oka from the kilogram. Also the Greek committee of Standardization publishes tables of transformation and many designs for the manufacture of new weights.