Review of St. Kitts-Nevis Soil Survey

April-May 1986

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I. INTRODUCTION

The USAID Regional Development Office/Caribbean in cooperation with the government of St. Kitts-Nevis is funding a Resource Management Project (RMP) to improve the conservation and utilization of land resources on the two islands. Technical assistance is being provided through Devres, Inc. by John Geter, RMP Project Coordinator, and James Fisher, RMP Water Resources Specialist. They have identified problems in the use of the soil survey (Lang, D.M. and D.M. Carroll. 1966. Soil and Land-use Surveys, No. I6, St. Kitts and Nevis. Regional Research Centre of the British Caribbean at the Imperial College of Tropical Agriculture, Univ. of the West Indies, Trinidad) as a base for land use and conservation planning.

In response to a request from the USAID Regional Development Office-/Caribbean, the USDA Soil Conservation Service through the Soil Management Support Services Project provided a soil scientist to make a field evaluation of the 1966 soil survey. Field studies were made in the period from 26 April through 5 May with the very helpful guidance and assistance of John Geter on St. Kitts and James Fisher on Nevis. With their enthusiastic cooperation it was possible to use Saturdays, Sunday morning, and the labor day (5 May) holiday for field studies.

The two islands of Nevis and St. Kitts are federated but they have separate agencies for agriculture, their soils and agriculture are very different, the 1966 soil surveys (although published together in one report) were made by different people and differ in map detail, and the two islands are treated separately by different technical assistance specialists in the St. Kitts-Nevis Resource Management Project. Therefore, the islands are considered separately in this review.

II. REVIEW OF ST. KITTS SOIL SURVEY

We studied land use problems and examined soils in the field from 26 April through 1 May at 29 locations selected by Mr. Geter. These locations in project areas or other areas of interest distributed through the agricultural parts of the island represented 16 of the most extensive, productive, or critical soil series. At these locations, the soil profile was exposed by digging to a depth of 25 or 30 inches and augering to 60 inches or, in a few cases, to a rock fragment or sand too loose to stay in the auger at a lesser depth. The profile was not exposed in the beach and dune sand areas, stop 0, and road cut exposures were used at stops 13 and 24. Brief soil descriptions were made.

A. Soils and Agriculture

Excluding the southeastern peninsula, the soils on lower slopes of the island, on slopes ranging from 2 or 3% up to about 25%, are in sandy volcanic materials with a wide range in content and size of rock fragments. The volcanic materials, mostly lithic rather than glassy,

probably include water-transported and debris-flow deposits as well as direct, air-fall deposits. The thickness of surface and subsoil layers with texture of sandy loam or finer ranges from 6 to over 25 inches. Underlying material has loamy (fine) sand or (fine) sand texture. Lack of soil moisture is regarded as more limiting for plant growth on the south side of the island than elsewhere. Soils on higher, steeper slopes in the central part of the island, have finer textures. The peninsula, to the southeast, has nearly level, sandy soils in beach and dune deposits near sea level and clayey, stony soils over consolidated rock on hill slopes.

Most of the agricultural land is in sugarcane and has been for perhaps two hundred years or more. Large farms (formerly private estates) of several hundred acres as well as the cane transport system and the sugar mill are now operated by the government. There is very little privately owned agricultural land. Some small-scale farming is on land made available on the sugar estates, on private land, or on public other land used without legal rights. In some areas, tillage before planting is mechanized but most operations are by hand labor. Root and vegetable crops, cattle, goats, and sheep are grown, probably mostly for home consumption.

Water sources well up the volcano were developed years ago by the various estates and water is piped down to the coastal and lowland residential areas. Water for livestock is a critical limitation. At least one livestock farmer collects water from palm trees by installing a metal sheet on the tree to divert the flow of water down the stem into a storage barrel.

B. 1966 Soil Survey

The 1966 soil survey was made by D. M. Carroll. The soil map, at a scale of 1:25:000, is on a base that does not give enough reference points to locate mapped areas accurately on the ground. The map shows greatest cartographic detail on the southeastern peninsula where there is essentially no agriculture. There, some delineations are as small as 2 acres and many are less than 100 acres. On the lower slopes of the main part of the island, which are cropped, the smallest delineations are about 20 to 30 acres and most delineations are more than 100 acres. The legend recognizes 33 soil series and two land classes. Soil delineations are assigned slope and erosion classes. Some delineations are complexes or undifferentiated units of two series. Soil descriptions are very brief and recommendations for management are few and very general. The strongly genetic and, to me, not very helpful soil classification is based on degree of maturity and mineral weathering.

The soil units observed at sample points during the review are listed in Table 1. According to the 1966 report, the area of these series is 31,580 acres and the total mapped area is 39,630 acres. Thus, the 16 series tested represent a large majority of the mapped land. The

Table 1. Comparison Between Soil Observed and Soils Mapped--St. Kitts

Stop No.	Map Symbol	Soil Identified	Match
0	1A	Cockleshell Bay	Fair
	2A	Frigate Bay	Fair
1	8BA	Sandy Bay	Fair
2	8BA	Sandy Bay	Fair
3	8BA	Sandy Bay	Fair
4	8BA	Sandy Bay	Fair
5	12C	Lavington's	Fair
6	9C	Harris	Fair
7	8BA	Sandy Bay	Poor
8	8C	Sandy Bay	Poor
9	15DC32	Mansion	Poor
10	15DC32	Mansion	Poor
11	14CB32	Estridge's	Poor
12	15DC32	Mansion	Poor
13	28F,28E	Sir Timothy's	Good
	27B	Conaree Hills	Good
14	10/13 CD	Pump	Good
		Vambelle	Poor
15	10/15 BC	Pump	Fair
		Vambelle	Poor
16	8BA	Sandy Bay	Fair
17	10BA	Pump	Poor
18	11C	Brotherson's	Fair
19	11B	Brotherson's	Fair
20	8BA	Sandy Bay	Poor
21	22DE2	Phillip's Level	Poor
22	22CB12	Phillip's Level	Poor
23	20BC21	Wingfield Level	Fair
24	16DE32	Duporte	Poor
25	8D	Sandy Bay	Poor
26	8B	Sandy Bay	Fair
27	5B	Shadwell	Fair
28	5C	Shadwell	Poor

comparison, reported in this table, between the soils as described in the report and as observed during the review mostly considers texture, content of rock fragments, and depth to rock; it specifically excludes slope. The slope classes shown on the map tend to underestimate the slope.

The description for Sandy Bay soils (10,410 acres) in the report shows 9 inches of "gritty loamy sand or sandy loam" over "gritty and gravelly loamy sand passing to sand". This profile would have very limited water holding capacity. At six out of ten observations in Sandy Bay soil delineations, the surface layer, of sandy loam or loam texture, was significantly thicker than 9 inches. At the other four check points there was a subsoil layer of loam or clay loam texture. All ten soils observed had water holding capacity significantly higher than that of the Sandy Bay soils as described.

Likewise, at two test points, soils observed in Shadwell delineations (6,870 acres) were significantly less coarse-textured and more favorable for crops than Shadwell as described.

Distinctions made in the report among Brotherson's, Sandy Bay, Harris, Lavington's, and Pump soils were not substantiated by observations in the field.

The map shows some areas with Pump and Vambelle soils as primary and secondary components, respectively. The only soil somewhat like Vambelle as described was seen not in one of these areas but in a Pump area without Vambelle listed as a component of the map unit.

The Mansion, Estridge's, Duporte, Phillip's Level, and Wingfield Level soils are all described over "agglomeratic tuff" or "stony tuff" at various depths of 36 inches or less. Eight soils were observed: seven were deeper than 60 inches; one was observed to a depth of only 48 inches because the auger was stopped by a rock fragment. On the other hand, the Conaree Hill and Sir Timothy's soils are over consolidated rock as described, although in some cases the rock is agglomerate rather than andesite.

Soils on the upper volcanic slopes were not observed during the review.

The 1966 soil survey provides a general guide to the nature of the soils of St. Kitts but it is not adequate as an inventory of the soil resources.

C. Needs for Additional Soil Survey Assistance

St. Kitts is faced with major changes in its agriculture. If the sugar industry is to survive, very probably sugarcane production will need to be concentrated on the best land with improved management to increase efficiency and to maintain or increase total production. Alternatively, sugarcane may be lost completely as a commercial crop. In either event, significant areas will be released for other crops and many, major decisions will be needed about changes in land use and soil and crop management.

As indicated above, the 1966 soil survey lacks the cartographic detail and accuracy and the descriptive and interpretative information needed to support sound land use planning and land management decisions within the current Resource Management Project and beyond. A modern, detailed soil survey for at least the agricultural lands of the island is needed as a base for land use and management choices and decisions.

Because the area is small (about 43,000 acres), the unit-area cost of a new soil survey will be high. The island has a range of diverse soils. Each kind of soil will require careful study and description even though the extent of that soil is small. I estimate that field work for a second order (detailed) soil survey of about 25,000 acres of the best land for crops and pasture and third or fourth order survey of other areas would take about 12 person-months including work to evaluate the qualities and behavior of the soils and prepare the report manuscript. Preparation of maps and review and publication of the report would take additional time. This does not allow for laboratory analyses or for the time of soil correlators.

If it is decided that a new soil survey is not possible and that an alternative approach is needed within the schedule of the RMP, my suggestion is to interpret and update the existing soil survey with the technical assistance of a soil scientist (soil survey specialist) for at least three months.

D. Scope of Work for a New Soil Survey of St. Kitts

1. Objectives
   a. Provide a reliable, detailed inventory of the soils of St. Kitts
   b. Relate this inventory to a widely-used system of soil survey so that information can be transferred from other places.
   c. Put the inventory into a readily-understandable and usable form.
   d. Train local agricultural specialists to use the information and supplement it with further studies as necessary.

These objectives can be met by a soil survey using the standards of the U.S. National Cooperative Soil Survey as expressed in the publications and practices of the USDA/SCS made with special attention to train local land management specialists. A second order soil survey is needed for agricultural land; third or fourth order soil survey is appropriate for the southeastern peninsula and the upper slopes of the central mountains.

2. Schedule: The work should be done as soon as possible. The main rainy season (centered in October) and the cover of sugarcane from June or July until harvest some time between January and May are obstacles to field access. The advantages of interactions between two soil scientists probably outweigh the advantages of extra time for field reviews and soil correlation if one person does the whole job. Therefore, I suggest a lead soil scientist for seven months with an assistant for five months. The soil map should be available as copies of the field sheets and the report manuscript should be available in draft form on completion of the survey without waiting for map compilation, editing, or review.

E. Budget for a New Soil Survey of St. Kitts (U.S. $; exclusive of indirect costs and fees)

I. Technical Assistance (Soil Survey Specialists for twelve months)

A. Salary	48,000
B. Subsistence	36,000
C. International travel	2,400
D. Field and office equipment	5,000
Total	91,400

II. Technical Support (for soil classification, correlation, and interpretations)

A. Salaries	10,000
B. Subsistence	3,000
C. International travel	2,400
Total	15,400

III. Technical Support (for map compilation, manuscript editing and review, and report publication)

Total	20,000

IV. Local Support

A. Professional salaries	30,000
B. Labor or backhoe or both	4,000
C. Local transportation	2,000
D. Secretarial assistance	5,000
Total	41,000

F. Scope of Work to Update the 1966 Soil Survey of St. Kitts 1.

1. Objectives
   a. Define and classify the major soils on slopes up to about 25%.
   b. Simplify and revise the map legend.
   c. Update the map.
   d. Provide guides for onsite evaluation of slope and surface cover of rock fragments.
   e. Provide interpretive ratings for the soils.

2. Schedule: The work should be done as soon as possible and at least field aspects must be done before field activities are curtailed by the major rainy season beginning probably in September. About three months of effort will be needed.

3. Necessary Local or RMP Support
   a. Make the existing soil map useful in the field by redrafting it on the topographic map so that the boundaries can be located on the ground and by making copies of portions of the map, area by area, on sheets of convenient size.
   b. Evaluate weather data and any other information relative to soil moisture limitations for plant growth.

c. Analyze field-by-field data on sugarcane yields, variety, fertilization, weather, year after planting, time of harvest, etc. as a basis for evaluating the quality of the soils for crop growth.
d. Collect and evaluate information on performance of the soils for other crops.
e. Assign a soil or crop scientist (such as Mr. Crossman) to work with the soil survey specialist.
f. Dig soil pits at the direction of the soil surveyor for description of soil profiles either with a backhoe or by hand labor.
g. Arrange for entry into sugarcane and other fields as necessary for soil studies.
h. Provide office facilities and local transportation.

4. Qualifications of Soil Scientist: Field experience in the U.S. Cooperative Soil Survey for at least five years. Experience in several soil survey areas and in interpretations and preparation of legends and reports. Experience in tropical areas highly desireable. It is unlikely that any one in a position with civil service rating less than 12 will have the necessary qualifications.

5. Duties of Soil Survey Specialist: With the help of local people
a. Study, describe, classify, and evaluate the soils of the agricultural land areas in the field. Up to 100 or more complete pedon descriptions will be needed.
b. Evaluate possible inaccuracies in the 1966 map that are suggested by local information on behavior of the soils, analysis of sugarcane field-by-field yield data, RMP activities, etc.
c. Determine the kinds of soils (broadly defined series within families of Soil Taxonomy) important for agricultural land use and management planning and decisions. Some combinations and subdivisions of the "soil series" of the 1966 report will be appropriate. The emphasis should be on major distictions of agricultural significance. Recognition of more than ten kinds of soil (not counting slope and stoniness classes) for the major agricultural areas probably would detract from the usefulness of the work.
d. Work with local people to assemble the best information about the qualities and behavior of the soils (including moisture relationships) through discussions, meetings, and field tours with soil and crop specialists, land managers, field workers, tractor operators, and farmers. (Local people with experience on the land always know more, in their own terms, about the soils than any visiting expert.)
e. Establish interpretive ratings as outlined in the USDA/SCS National Soils Handbook for soil properties, features, and suitabilities such as erodibility factor (K), hydrologic soil group, available water capacity, permeability, crop yields, etc.
f. Provide guides (photographs, descriptive material, typical locations, etc.) and training for onsite recognition of classes of surface cover of rock fragments and slope.
g. Revise the redrafted 1966 soil map on the basis of information developed in previous activities without comprehensive remapping or field checking.
h. Report the results of these activities in a form convenient for the RMP and future planning and management decisions.

G. Budget to Update the 1966 Soil Survey of St. Kitts (U.S. $; exclusive of indirect costs and fees)

I. Technical Assistance (Soil Survey Specialist for three months)

A. Salary	12,000
B. Subsistence	9,000
C. International travel	600
D. Field and office equipment	1,000
Total	22,600

II. Local Support

A. Professional salaries	9,000
B. Labor or backhoe or both	2,000
C. Local transportation	600
D. Secretarial assistance	600
Total	12,200

III. REVIEW OF NEVIS SOIL SURVEY

We examined the soils in the field from 2 through 5 May 1986 at 29 well-distributed locations selected by Mr. Fisher. These locations in project areas or other areas of interest represented 12 of the most extensive, productive, or critical soil series. At these locations, the soil profile was exposed by digging to a depth of 20 or 25 inches and augering to 60 inches or, more commonly, to some very gravelly, stony, or indurated layer. Brief soil descriptions were made.

A. Soils and Agriculture

Soils on lower slopes, outside of the ghuts (intermittent stream channels), stream flood plains, and back beach areas, very predominantly have clayey subsoil layers. Great quantities of rock fragments have been removed from fields but, in many cases, remaining fragments would interfere with mechanized tillage. In many other areas, use of mechanized farm equipment is impossible or very strongly limited by stones and boulders. Present land use strongly suggests that lack of sufficient soil moisture limits crop production in much of the southern part of the island. Soils in the central part of the island, on slopes ranging from about 25 to 100 percent and steeper, are mostly forested and apparently never have been cropped.

Much of the agricultural land was once used for sugarcane. Apparently, there was never a central mill and sugarcane was dropped as a commercial crop as the small plantation mills were shut down. Cotton production has declined to a few hundred acres operated by the government. Most of the land is privately owned. In drier parts of the island much land, formerly cropped as shown by roads, fields outlined by stone fences, and piles of stones cleared from the fields, is not cropped and lies idle except for browsing and grazing. Areas with more favorable soil moisture have many very small farms with a variety of root, vegetable, and fruit crops. Pastures, mostly with volunteer vegetation, are utilized by tethered or fenced goats, sheep, or cattle. Small scale irrigation is being developed on a few small project areas. Coconut plantations ranging from sea level to over 1000 feet elevation are producing but most are not harvested.

B. 1966 Soil Survey

The 1966 survey was made by D. M. Lang. A few delineations are as small as 2 acres; many are smaller than 40 acres. The soil map, at a scale of 1:25,000 is on a base that does not give enough points to locate mapped areas accurately on the ground. The legend recognizes 24 soil series and six land clases. Four series have stony or bouldery phases or both. Soil delineations are assigned slope and erosion classes. Some delineations are complexes or undifferentiated units of two series. Soil descriptions are brief and recommendations for management are few and very general. The strongly genetic and, me, not very helpful soil classification is based on degree of maturity and mineral weathering.

The soil units observed at sample points during the review are listed in Table 2. According to the 1966 report, the area of these series is 15,674 acres and the total mapped area is 19,971 acres (including 2,667 acres of land types without soil identification). Thus, the 12 series tested represent a large majority of the mapped land. The comparison, reported in this table, between the soils as described in the report and as observed during the review mostly considers texture of surface and subsoil layers and specifically excludes slope and amounts of surface rock fragments.

Soils mapped as Charlestown (8,636 acres) were found to have thin surface layers of clay loam or clay and subsoil layers (Bt horizons) with clay texture, weak structure, and slow or very slow permeability. These soils crack to the surface when they dry and the subsoil layer shows features (dark streaks and slickensides) that indicate high shrink-swell and churning activity. Underlying layers were not directly observed but cuts and landscapes suggested a cemented pan over unconsolidated sediments in some places (more or less as described in the report) and tuff, agglomerate, or lava bedrock in other places. Some soils mapped as Jessup's, Prospect, Fig Tree, and Maddens are similar.

Other soils mapped as Prospect, Fig Tree, Maddens, Rawlins, or Potwork have a thicker surface layer of clay loam, loam, or sandy loam and a clayey subsoil layer that is more favorable for penetration of roots and water. Distinctions among these soils made in the report are not demonstrated convincingly in the field.

Soils on steep slopes and especially at higher elevations (observed at stops 26 and 28) range widely in depth, texture, content of rock fragments, and degree of horizon differentiation.

The 1966 survey provides a useful but not fully adequate inventory of the lower, agricultural slopes of the island. It gives little reliable information for soils on slopes steeper than about 20%.

C. Needs for Additional Soil Survey Activities

The 1966 soil survey is not adequate to support land use planning or land management decisions within the current Resource Management Project (RMP) or beyond. Assistance is needed to replace it or make it more useful. I favor an approach to update the 1966 survey rather than make a new soil survey because (1) the 1966 map does provide a useful base for an update, (2) many agricultural parcels are small compared to delineations possible on even a detailed soil map, (3) the present agriculture seems to be adjusted to the land resource through trial-and-error experience, (4) major changes in land use and management can be expected primarily on relatively small parcels in project areas, and (5) the current RMP and other activities need soil information soon.

Table 2. Comparison Betwen Soils Observed and Soils Mapped--Nevis

Stop No.	Map Symbol	Soil Identified	Match
1.	6/5 A 0/1	Napier	Fair
		Prospect	Poor
2.	24 A1/B2	Jessup's	Fair
3.	16/15/13 B 1/2	Fig Tree	Poor
		Charlestown	Good
4.	5 A0/B1	Prospect	Fair
5.	20 A/B 0	Maddens	Good
6.	13B2	Charlestown	Fair
7.	13B2	Charlestown	Good
8.	31C	Rawlins	Poor
9.	16 C/D 1	Fig Tree	Fair
10.	16C	Fig Tree	Poor
11.	31 B/C	Rawlins	Poor
12.	31 C/D	Rawlins	Fair
13.	5A0	Prospect	Good
14.	7A 1/2	Clay Ghut	Good
	5A+	Prospect	Fair
15.	13B2	Charlestown	Good
16.	18 B/C 1	Potwork	Fair
17.	20B 1/0	Maddens	Good
18.	20B 1/0	Maddens	Fair
19.	6B+	Napier	Good
20	3A0	Lawrence	Poor
21	3A0	Lawrence	Good
22	13 B/C 3	Charlestown	Good
23	17B1	Potwork	Good
24	17B1	Potwork	Good
25	20/21 B2	Maddens	Good
26	33/26 D2	Hilltop	Good
		Saddle Hill	Good
27	21B/22A 2	Maddens	Fair
28	26 E2/F3	Saddle Hill	Good
29	16 B0/C1	Fig Tree	Good

Updating the survey for the agricultural land (lower slopes up to 20 or 25%), would require about 10 person-weeks of technical assistance with adequate local support. (A new soil survey would take about 10 person-months in-country plus additional time for soil correlation, cartographic work, manuscript review, and publication.)

D. Scope of Work to Update the 1966 Soil Survey of Nevis

1. Objectives
   a. Define and classify the major soils on slopes up to about 25%.
   b. Simplify and revise the map legend.
   c. Update the map.
   d. Provide guides for onsite evaluation of slope and surface cover of rock fragments.
   e. Provide interpretive ratings for the soils.

2. Schedule: The work should be done as soon as possible and at least field aspects must be done before field activities are curtailed by the major rainy season beginning probably in September. A minimum of ten weeks effort will be needed.

3. Necessary Local or RMP Support
   a. Make the existing soil map useful in the field by redrafting it on the topographic map so that the boundaries can be located on the ground and by making copies of portions of the map, area by area, on sheets of convenient size.
   b. Evaluate weather data and any other information relative to soil moisture limitations for plant growth.
   c. Provide ready access (through written reports or oral exchanges with experts such as Elvin Bailey, Claude Nisbett, Bridge Goel, Jenny Lowery, and Ian Corker) to information about soils and crops.
   d. Assign a soil or crop specialist to work with the soil survey specialist.
   e. Arrange for entry to the land as necessary for soil studies.
   f. Dig soil pits at the direction of the soil surveyor, probably with a backhoe because of the clay texture and high content of rock fragments of many soils.
   g. Provide office facilities and local transportation.

4. Qualifications of Soil Survey Specialist: Field experience in the U.S. Cooperative Soil Survey for at least five years. Experience in several soil survey areas and in interpretations and preparation of legends and reports. Experience in tropical areas highly desireable. It is unlikely that any one in a position with civil service rating less than 12 will have the necessary qualifications.

5. Duties of Soil Survey Specialist: With the help of local people
   a. Study, describe, classify, and evaluate, including in the field the soils of the major agricultural land areas, including previously cropped. Up to 100 or more complete pedon descriptions will be needed.

b. Evaluate possible inaccuracies in the 1966 map that are suggested by other workers and observations incidental to the descriptive work.
c. Determine the kinds of soils (broadly defined series within families of Soil Taxonomy) important for agricultural land use and management planning and decisions. Some combinations and subdivisions of the "soil series" of the 1966 report will be appropriate. The difference between "Soils mapped as Charlestown" and "Other soils mapped as Prospect, Fig Tree, Maddens, Rawlins, or Potwork" outlined in section B (above) should be recognized as well as ustic and udic moisture regimes, skeletal and nonskeletal conditions, and presence of lithic contact or duripan. The emphasis should be on major distictions of agricultural significance. Recognition of more than ten kinds of soil (not counting slope and stoniness classes) for the major agricultural areas probably would detract from the usefulness of the work.
d. Work with local people to assemble the best information about the qualities and behavior of the soils (including moisture relationships) through discussions, meetings, and field tours with soil and crop specialists, land managers, and farmers. (Local people with experience on the land always know more, in their own terms, about the soils than any visiting expert.)
e. Establish interpretive ratings as outlined in the USDA/SCS National Soils Handbook for soil properties, features, and suitabilities such as erodibility factor (K), hydrologic soil group, available water capacity, permeability, crop yields, etc.
f. Provide guides (photographs, descriptive material, typical locations, etc.) and training for onsite recognition of classes of surface cover of rock fragments and slope.
g. Revise the redrafted 1966 soil map on the basis of information developed in previous activities without comprehensive remapping or field checking.
h. Report the results of these activities in a form convenient for the RMP and future planning and management decisions.

E. Budget to Update the 1966 Soil Survey of Nevis (U.S. $; exclusive of indirect costs and fees)

I. Technical Assistance (Soil Survey Specialist for three months)

A. Salary	12,000
B. Subsistence	9,000
C. International travel	600
D. Field and office equipment	1,000
Total	22,600

II. Local Support

A. Professional salaries	9,000
B. Labor or backhoe or both	2,000
C. Local transportation	600
D. Secretarial assistance	600
Total	12,200