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Cost Allocation in Water Resources - Two Gaming Experiments with Doctoral Students

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COST ALLOCATION IN WATER RESOURCES--TWO GAMING EXPERIMENTS WITH DOCTORAL STUDENTS

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PREFACE

This paper is one in a series of reports on experiments with a game concerning cost allocation in water resources. The ultimate purpose of the game is to be an aid in finding better methods for allocating joint costs in projects when several parties, e.g. municipalities, join together to save costs by building a larger facility instead of several smaller ones.

Gaming, i.e. the actual playing of games, can be seen as a compliment to other, more deductive, methods, e.g., game theory. Since the idea is that the planners involved shall really want to use the allocation scheme, it is important that the scheme is congruent with the planners' own thinking. Gaming can first of all be seen as an "acid test" of the proposed game theoretic suggestion. If some theory is not appealing in an experimental setting, it is most likely not so in real application either. Furthermore, gaming can be seen as a direct way of finding out what ideas of distribution are really held by planners: How do intelligent decision makers, with a reasonable time for thinking through the problem, arrive at a compromise between different concepts, such as efficiency and equity, in negotiations of this type?

ABSTRACT

This paper reviews two gaming experiments with a game on cost allocation in water resources, carried out with doctoral students. The game is aimed at testing some different methods of cost allocation. Although many repeated game runs are necessary for conclusions, the main results of these two experiments, together with two earlier experiments on the same game but with real decision makers, are as follows:

1) The method of allocating costs in proportion to demand was far worse as a predictor of outcome than any of the other methods discussed here.

2) Of the four game theoretic methods, the method preferred from a normative point of view fared worst in all four games.

3) In none of the four games the solution was in the core.

4) In every game the coalition formation process started with some smaller coalitions being formed, then going on towards larger coalitions.

5) There were fairly great differences between the decision makers and the students both with regard to outcomes and the negotiation process.

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COST ALLOCATION IN WATER RESOURCES--
TWO GAMING EXPERIMENTS WITH DOCTORAL STUDENTS

Ingolf Stahl

1) INTRODUCTION

IIASA working papers WP-80-38 and WP-80-82 contain descriptions of a game on cost allocation in water management as well as a report on the actual playing of this game; first in November 1979 with water planners in Sweden, and secondly in April with regional planners in Tuscany, Italy. The reader is recommended to read either one of these two working papers prior to proceeding to the present one.

Although the focus of the IIASA gaming project is to involve, as far as possible, real decision makers, it is also of importance to obtain many game runs to be able to study the structure of the game more generally. When an opportunity was given to run this water game twice with Swedish doctoral students in Cultural Georgraphy from the University of Lund* the opportunity was gladly utilized.

The idea was not only to try out some new experimental designs, but also to test if the above stated policy of trying hard to involve real decision-makers was reasonable. If students played in the same way as real decision makers, it would not be reasonable to put a lot of effort into involving real

*They were on a study tour in Vienna. Several of them were doing research related to regional planning.

decision-makers since students would, in general, be more easily obtainable. Our earlier literature studies had suggested that there would probably be substantial differences between the way students and real decision-makers act. However, we had not found many well-done comparisons in this regard, in the literature and furthermore, the comparisons involve games of a somewhat different type than our game.* This made it seem interesting to get a chance to make our own test of our working hypothesis; that there would be a significant difference in behavior between real decision-makers and students.

2) THE EXPERIMENTAL DESIGN

The experimental design that we wanted to try out was influenced by the outcome of the playing in Sweden and Italy. In both cases, the game theoretic concept that had been less successful from a predictive point of view, was a concept which from a normative point of view had been regarded to have the most desirable properties,** namely the Weak Least Core.

The reasons that this concept had been preferred from a normative point of view, were the following: First, the solution should lie within the core.*** Secondly, the game theoretic procedure used should obey what is called the monotonicity principle. This requires that if total costs go down, no party shall pay more. The Weak Least Core appears to be the only well-known core concept fulfilling the monotonicity requirement in every game.

The two earlier experiments had in no way given the participants any reasons for reflecting upon the monotonicity principle, since they had not had to think about the effect of total costs going up or down. In order to draw the attention of the participants to this question, we allowed in one of the two experiments, (group B) for two levels of costs of the grand coalition, i.e., when all six municipalities join together; one of 83.82 mkr (millions of Swedish crowns); one of 87.82 mkr. The 83.82 figure is the one used in the previous experiments. The reason for putting the second level 4 mkr. above, is that this is the figure used by Young et alia in WP-79-77. For this pair of figures, it is shown that the Nucleolus, which in the two previous experiments was the most successful of the three studied core concepts, violated the monotonicity principle. When total costs are 83.82, party K pays 5.00; when costs increase to 87.82, K pays only 4.51.

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*See further Stahl (1980 c)

**See WP-79-77

***For a definition of this concept, see, e.g., page 3 in WP-80-38.

The two cost levels were introduced in the game instructions for party B, both by giving the two figures for the AHKLMT coalition and by introducing the following passage:

> As noted above, the cost of the grand coalition AHKLMT, will either be 87.82 mkr. or 83.82 mkr. depending on whether the government will give a special subsidy of 4 mkr. for the plant of this coalition. No government subsidy will be given to any coalition other than the grand coalition AHKLMT. Whether the subsidy really will be paid or not, will not be determined until after the game is finished, with either event being equally likely. Therefore, every grand coalition must register two payment distributions, one for the case when costs are 87.82 and the other for the case when costs are 83.82 mkr.

The game instructions for the other game group, group A, did not include this information (set out in the appendix within square brackets). Apart from this difference, the instructions for the two groups A and B, were identical.

The instructions in the version played here differed, however, also in other respects from the game played in Sweden and Italy.

In the game in Sweden, we did not include any data on water demand and population. In the Italian game, we supplied data on both of these factors. Although the relevance of these factors was discussed at length in the Italian game, they did not have any influence on the final outcome. As discussed in WP-80-82, the presentation of data on both population and water demand might have made it more difficult for those arguing for the viewpoint that the division should reflect such figures. They could not clearly decide on whether demand or population should matter. It therefore seemed to be of interest to study the effect of presenting data on water demand only. This was thus done for both the two games described here.

Furthermore, due to practical circumstances, we decided, unlike in the two earlier games, not to let the students play for money in direct proportion to the pay-off table.* Instead, it was stated that a prize would "be given to that player who according to the judgment of the game leader acts as the most skillful representative for his municipality among the twelve players taking part in the two games."

The idea was that the hope of getting this prize would serve as almost as strong a stimulator as letting each player have the chance of obtaining a small amount of money. In fact,

*One million crowns in the table in the Swedish game corresponded to one crown, and in the Italian game, a hundred lire.

in the Italian and Swedish game, all the money won by the participants had been given away to charity. Therefore, the effect of the money had probably been fairly low.

Finally, there were some small changes in the break-up rules, particularly compared to the Swedish games, in order to avoid the game being broken up prematurely.

3. THE PLAYING OF THE GAME

The two groups of players were seated around two separate tables located in the same room, but approximately 10 m. apart. There appeared to be little possibility of either group observing what the other group did, but it was possible for the game leader to be in contact with both groups.

The seating around each table was intentionally kept the same as in the earlier games, viz. the following (figure 1):

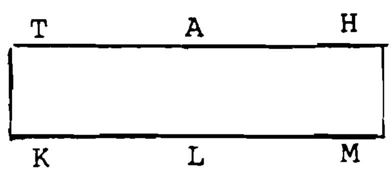

Figure 1. Seating plan.

The participants were for practical reasons allotted to groups A and B according to the order of arrival to the experiment. Within each group, the municipality roles were allotted to the six players.

The participants obtained the gaming instructions presented in the appendix with group B obtaining the full text and group A, the text except that which has been placed within square brackets in this appendix.

Initially, there was time for questions, but there were no questions that could not be given an answer by directly referring to the gaming instructions. These questions did not reveal that the two teams did not play identical games.

As regards the playing of the game, we shall report on each group separately.

3a) Group A

In team A, in which the cost of the grand coalition was unique, 83.82, the parties started off trying to form the grand coalition, and then dividing this cost 83.82 into six equal parts, i.e., 13.97 to each. Since this procedure would give e.g., K much higher costs than if he was on his own (10.91), this idea was rejected.

Next, the parties tried to allocate costs according to demand and then see if anyone would "suffer". Since M is then better off on his own, this procedure was also rejected. After this, the parties seemed to give up the attempts at forming the grand coalition immediately.

After 22 minutes (counted from the start of the game) AHT tried to form a coalition, but could not agree on a division. After 28 minutes, K and L wanted to form a coalition with 13.80 to K and 12.99 to L. This division was proportional to the water demand of K and L. When the game leader asked whether he also agreed to this division scheme, K realized that he would only have to pay 10.91 when on his own, and therefore retracted from this agreement.

The negotiation then proceeded with many calculations and much discussion on the part of the participants. After 47 minutes, AHT had finally been able to reach an agreement on 20.50 to A, 15.64 to H and 20.53 to T. This division was obtained by computing the total savings: $c(A)+c(H)+c(T)-c(AHT)$; dividing these savings into three equal parts and then deducting each party's share of savings from his costs when playing alone. It should be stressed that the coalition AHT makes little sense, since T adds nothing in terms of cost savings. One wonders if the fact that AHT sat on the same side of the table had any effect. Furthermore, this division was obviously not in the core as regards the division of the costs of AHT, since AH would be better off alone, not having to share any of their cost savings with T.

After approximately one hour from the start of the game, KLM tried to divide the cost savings of 5.59 obtained by this three-party coalition. The debate centered on whether these savings should be divided into equal parts of 1.86 or whether they should be divided according to water demand, something heavily favoring party M, who faced 67 per cent of the total demand of this coalition. Finally, a compromise was reached on a division of the savings, lying in between the division figures according these two methods. This gave a division of 9.41 to K, 14.48 to L, and 18.01 to M. It can be noted that this division does not lie within the core of this three party coalition KLM. Since K does not contribute to any savings, L and M would be better off with the LM coalition only.

After this, all players in group A worked on forming the six party coalition. Time was then running short, since there was a total time limit of 90 minutes stipulated.

There was a general agreement that the foundations of the division of the costs of this grand coalition was that each party should go in with his payments from the registered three-party coalitions and that one from these payments should deduct the savings obtained by forming the six party coalition i.e., c(AHT)+c(KLM)-c(AHKLMT). Just before time ran out, there was an agreement on dividing these savings in proportion to water demand leading to the following cost distribution: A = 18.15; H = 12.77; K = 8.10; L = 13.25; M = 12.90 and T = 18.65.

As regards this outcome, one can first note that it does not lie within the core. In fact, it violates the group rationality principle in many ways. The following coalitions all lead to less costs to their members than the sum of the payments according to the division above: HL, AHL, HKL, and AHKL.

In particular, it is noteworthy that H and L could get away with paying 12.50 each, if they just formed the HL coalition and split their costs equally. Thus the players H and L violated Selten's Equal Share Analysis theory which is based on observations of behavior in similar experiments. According to this theory (Selten, 1972, p. 133 and Selten, 1978, p. 296), the solution should lie in the equal division core. This implies that no alternative coalition should be able to form, which by charging each party the same amount, would have lead to a lower pay-off. The HL payments of 12.77 and 13.25 are obviously not in this equal division core, since they are lower than the 12.50 noted above.

Furthermore, one can discuss whether it is reasonable to divide cost savings in proportion to water demand. This implies that the more water one demands, the lower costs one would have to pay.* Here, one wonders to what extent the time pressure combined with the argumentative skills of the representative of municipality M, played a significant role. At any rate, the procedure adopted lead to the fact that M in this game had to pay far less than M had paid in any other game, and also according to any division procedure discussed in WP-79-77.**

3b) Group B

The players in group B started off by trying to form a grand coalition and dividing costs in proportion to water consumption. But since this violated individual rationality, no agreement could be reached. After 13 minutes, there was an attempt to form a coalition AHKL, sharing costs equally, but this was also dropped due to violation of individual rationality.

Instead, there was a focus on formation of smaller coalitions and after 20 minutes, H and K formed HK, dividing the total costs of 22.96 in proportion to the water demand, giving a division of 15.77 to H and 7.19 to K.

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*It should be stressed that since costs refer to a plant of a given size, this division procedure cannot rationally be defended by referring to economies of scale.

**M in group A hence obtained the first prize, a BBBB (Best Bulgarian Brandy Bottle).

After 25 minutes, the coalition HKLM wanted to sign up with the following division: H: 13.08, K: 5.96, L: 5.6, and M: 23.27. This is a division of the total costs of this coalition, 48.07, in proportion to water demand. When asked by the game leader whether everyone in the coalition agreed to this division, M realizing he could pay less on his own, retracted.

Instead, a coalition HKL was formed after 30 minutes with 14.4 to H, 6.5 to K and 6.3 to L. This was also a division based on water demand, but it now did not violate individual rationality.

The remaining time was used trying to form a grand coalition. The members of the HKL coalition then wanted to act according to broader regional-social criteria. They stated that they were willing to absorb more costs than they would have to pay if they remained in the HKL coalition, i.e., to violate "group rationality" in order to ensure that the societal optimal grand coalition would be formed.

The division scheme then worked out was quite complicated: First of all, one agreed upon how one would divide the 87.82, i.e., the costs prior to the government subsidy of 4. These 87.82 were first tentatively allocated to each party in direct proportion to each party's "one-party coalition" costs, giving A = 17.73, H = 13.83, K = 8.78, L = 12.02, M = 17.74, T = 16.80. Some adjustments were then made, apparently on some fairly ad hoc basis, taking into account the fact that by this procedure K lost 2.28 compared to the earlier HKL coalition. Due to this, K's payment was reduced to 7, and L's to 9. The other parties' payments were consequently raised somewhat. Thus, the final division of the 87.82 was: A = 18.67, H = 13.79, K = 7, L = 9, M = 18.55 and T = 19.98. Since HKL then had to pay 29.79 together, i.e., more than the 27.26 to be paid if on their own, the solution was not in the core.

The parties then went on to determine the division for the case that costs of the grand coalition would be 4 less. This division was made by distributing the cost savings of 4 particularly to those parties that were thought to have been less well treated in the earlier phase. Thus L's payment was, e.g., reduced from 9 to 8. The final division of the 83.82 was: A = 18.56, H = 13.79, K = 6.75, L = 8, M = 17.66 and T = 19.05. This is the division which we shall use for further analysis, since it involves the division of the same amount, 83.82, as in all other games.

It should be noted that this solution is not in the core either. The payment to be made by HKL, 28.54, is more than they would have to pay if they had just formed the coalition HKL (27.26). As mentioned above, this violation was obviously taken with open eyes, pursuing another goal other than minimizing one's own costs. This is, however, the only violation of group rationality. Furthermore, the solution lies in the "equal division core", since 27.26/3 = 9.09 and both K and L pay less.

4) COMPARISONS BETWEEN METHODS AND OUTCOME

In order to facilitate a comparison of the solution of the methods with the outcomes in the two games, we present the following table (Table 1), in which we also include the outcome of the original Swedish game and the Italian game.

Table . Cost distribution according to different methods and actual outcomes.

	A	H	K	L	M	T
Demand Proport.	13.33	16.32	7.43	7.00	29.04	10.69
SCRB	19.54	13.28	5.62	10.90	16.66	17.82
Shapley Value	20.01	10.71	6.61	10.37	16.94	19.18
Nucleolus	20.35	12.06	5.00	8.61	18.60	19.21
Prop Least Core	19.81	12.57	4.35	9.25	19.85	17.99
Weak Least Core	20.03	12.52	3.94	9.07	20.11	18.15
Swedish Game (if Grand)	21.15	9.70	6.00	9.10	18.37	19.50
Italian Game	20.81	9.55	6.10	8.88	18.72	19.77
Game A	18.15	12.77	8.10	13.25	12.90	18.65
Game B	18.56	13.79	6.75	8.00	17.66	19.05

Already in this table, it can be seen clearly that the outcome of the two games do not accord with the divisions based on demand proportionality.

In order to make it easier to compare the different methods with the outcomes of the two games A and B, we shall use three measures of difference, namely the following:

1) The sum of absolute differences. With T_i as the theoretical value and E_i as the experimental value for party i, the measure is:

$$\sum_{i=1}^{6} | T_i - E_i | .$$

2) The sum of the squared differences:

$$\sum_{i=1}^{6} (T_i - E_i)^2 .$$

Compared to measure 1, this gives a higher relative weight to large discrepancies.

3) The sum of the relative squared differences, i.e., of the squared differences after dividing each difference by the theoretical value:

$$\sum_{i=1}^{6} (T_i - E_i)^2 / T_i .$$

The idea behind this measure is that a difference is more important if it is relatively large in comparison with the "expected" value.

We list the methods in order of increasing difference with the outcome in the studied game. When one method is better with regard to two measures than another, it is regarded to have a lower difference than the other. We thus present the tables for game A (Table 3) and game B (Table 4). In these tables, we compare the outcome of the studied game with each of the theoretical methods as well as the forecasting method "that the outcome will be the same as in the Swedish game."* As reards both games, we see that allocation according to water demand gives by far the greatest difference. This might be surprising to the extent that the players in many of their allocations used water demand as a basis for the divisions. It must be remembered, however, that total costs were never actually allocated in proportion to water demand. Only cost savings were thus allocated, and it appears that this only happened when the cost savings were so comparatively small that it would not greatly matter whether one allocated in accordance with water demand or some other criterion.

Furthermore, the normatively "best" method, the Weak Least Core, is the worse of the remaining methods. The three best methods are the SCRB, the Shapley Value and the Nucleolus, with the latter being the best in Game B. The difference in outcome between game A and game B is fairly great, far greater than the difference between the Swedish and the Italian game.

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*Since the outcome of the Italian game is very similar to that of the Swedish game, it has been left out. The difference measures I, II, and III when applied to a comparison between the outcomes in the Swedish game and the Italian game were only 1.4, 0.4, and 0.1 respectively.

Table 3. Game A.

	Difference Measures		
	I	II	III
SCRB	12.7	28.7	2.6
Shapley	12.9	34.8	2.7
Game B	13.2	53.4	5.1
Nucleolus	16.9	69.3	6.5
Swedish Game	18.6	70.7	3.8
Prop. Weak Core	17.2	81.6	7.6
Weak Least Core	18.2	90.6	9.3
Water Demand	39.4	399.2	23.1

Table 4. Game B.

	Difference Measures		
	I	II	III
Nucleolus	7.0	10.5	1.1
SCRB	7.8	13.4	1.2
Shapley	7.8	17.7	1.6
Prop. Least Core	9.3	16.2	2.0
Weak Least Core	10.0	19.6	2.7
Swedish Game	9.7	25.9	2.3
Game A	13.1	53.4	4.13
Water Demand	29.2	234.6	13.6

Furthermore, we see that the difference between the outcomes in games A and B compared to the original Swedish game are also considerable.

5) GENERAL COMMENTS

In spite of these differences, there are, however, some traits that are common to all the games played this far:

1) The allocation proportional to demand has been far worse as a predictor of outcome than any of the other methods discussed here.

2) Of the four game theoretic methods, the Weak Least Core has in all four games fared worse, with the proportional Least Core following as the second worse. The Shapley Value and the Nucleolus have alternated being the best.

3) In none of the four games has the solution been in the core.*

4) In every game the coalition formation process started with some smaller coalitions being formed, then going on towards larger coalitions.

5) In all of the four games, there was some kind of reasoning of the following type:** When a larger coalition was being formed, one seemed to go in with some idea of "in-coming" costs from an earlier phase and one then computed the savings from forming the larger coalition. One then turned the decision towards the question of dividing these savings in order to finally deduct these allocated savings from these in-coming costs.

Finally, there should be a comment on the general difference in playing between the students in games A and B here, and the playing by professional people in the two earlier games. There was, as seen from tables 3 and 4, a substantial difference in the final outcome.

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*As regards games A and B, see pp. 6 and 7 above. In the Swedish and Italian games, the only violations of the core concerned the coalition AKLMT. Since L paid 9.10 (Swedish game) and 8.88 (Italian game) in the grand coalition, the five parties A, K, L, M and T would have been better off paying the cost of AKLMT of 73.97, which is 9.85 lower than the grand coalition cost of 83.82. The solution was, however, in the equal division core since 73.79/5 = 14.758.

**Although this may not be seen clearly from the description of Game B above, reasoning of this type did in fact take place also in Game B.

There also appeared to be a difference as regards the negotiation procedure. The students, e.g., spent much more time on calculations. In the earlier games, only one calculator was supplied for each group. In games A and B, each group had two calculators and yet there was a great demand for additional calculators. Furthermore, the whole negotiation process in the student games appeared to be characterized by more time pressure than in the earlier games. The students, e.g., bargained up to the very last minute. There also appeared to be a somewhat greater propensity among the students to calculate a division without really thinking through to what extent the division procedure really was meaningful. This comment applies, for instance, to the division of the cost savings in proportion to water demand. (See page 6).

Furthermore, it appeared that the students focussed somewhat more on the division aspects, and less on the coalition formations strategy aspects compared to the planners. The students formed, as mentioned, in several cases three-party coalitions, that lead to no cost savings compared to a two-party and one-party coalition. Finally, there were as indicated, two instances when a coalition registration was withdrawn, since it was found that individual rationality was violated.

It is very hard to believe that these differences were due to the different prize structure (see p. 3).* The difference must rather lie in the difference in background of the participants. One difference might lie in the extent to which the players were accustomed to working under stress in a negotiation environment. Another difference in the playing might be attributed to a greater habit among the planners to try to focus on the most relevant aspects, and less on computations.

Summing up, the experiment here appears to confirm our working hypothesis that a substantial difference in playing behavior might be expected between actual decision makers and students. Since the ultimate purpose of our research on operational gaming is to give some aid with regard to real decision making, our original decision to try, as far as possible, to get real decision makers involved in the games thus appears to be basically correct.

*The differences noted above, except for the near violation of individual rationality in two cases, hardly seems to be due to lack of motivation. Furthermore, student comments indicated high motivation to play well. A prize structure that would have lead to significantly higher motivation would probably have had to involve considerably more money than was involved in the Swedish and Italian games (see footnote on p. 3).

APPENDIX: GAME INSTRUCTIONS

You have been invited to participate in a simple game.

The game concerns the allocation of costs in a water project. This project aims at bringing stimulating liquid to six municipalities. You will represent one of these. On this occasion, as the sole representative of this municipality, you will represent both the producer and the consumer side.

You will participate in this project either completely on your own, or in cooperation with one or several of the other participants in the game, who are acting as representatives for other municipalities.

All in all, representatives of six municipalities, called A, H, K, L, M, and T, participate in the game. All participants (= municipalities) must in some way take part in the water project, but their costs will depend on how they form coalitions with other participants.

Should a municipality not enter into coalition with any other municipality, it will pay that sum in the allocated table which represents what each municipality would be obligated to pay if acting alone.

Each player can, however, by acting skillfully both during the formation of coalitions and during the allocation of the total costs within the coalition, get away with a lower payment, in some cases, a considerably lower one.

The details of the game are as follows:

By lottery, each player is assigned the role of the representative of one of the six municipalities. Next each player obtains the aforementioned sum of money corresponding to the maximum amount that he might have to pay, should he participate in the water project completely on his own. After this, the players sit down around the table and the coalition-formation negotiations can begin.

The players then must try to form coalitions and reach agreement on how much each of the participants in the formed coalition shall pay of the total cost to the whole coalition. This total cost for each possible coalition is seen in the attached table.

TOTAL COST OF EACH POSSIBLE COALITION
(in Mkr. = Millions of Swedish crowns)

A	21.95	AHK	40.74	AHKL	48.95
H	17.08	AHL	43.22	AHKM	60.25
K	10.91	AHM	55.50	AHKT	62.72
L	15.88	AHT	56.67	AHLM	64.03
M	20.81	AKL	48.74	AHLT	65.20
T	21.98	AKM	53.40	AHMT	74.10
		AKT	54.85	AKLM	63.96
AH	34.69	ALM	53.05	AKLT	70.72
AK	32.86	ALT	59.81	ALMT	73.41
AL	37.83	AMT	61.36	HKLM	48.07
AM	42.76	HKL	27.26	HKLT	49.24
AT	43.93	HKM	42.55	HKMT	59.35
HK	22.96	HKT	44.94	HLMT	64.41
HL	25.00	HLM	45.81	KLMT	56.61
HM	37.89	HLT	46.98	AKMT	72.27
HT	39.06	HMT	56.49	AHKLM	69.76
KL	26.79	KLM	42.01	AHKMT	77.42
KM	31.45	KLT	48.77	AHLMT	83.00
KT	32.89	KMT	50.32	AHKLT	70.93
LM	31.10	LMT	51.46	AKLMT	73.97
LT	37.86			HKLMT	66.46
MT	39.41				
				AHKLMT	83.82
					[or 87.82]

DATA ON WATER DEMAND

	A	H	K	L	M	T
Water Demand: (Mm^3/yr)	6.72	8.23	3.75	3.53	14.64	5.39

(As noted above, the cost of the grand coalition AHKLMT, will either be 87.82 mkr. or 83.82 mkr depending on whether the government will give a special subsidy of 4 mkr. for the plant of this coalition. No government subsidy will be given to any coalition other than the grand coalition AHKLMT. Whether the subsidy really will be paid or not will not be determined until after the game is finished, with either event being equally likely. Therefore, every grand coalition must register two payment distributions, one for the case when costs are 87.82 and the other for the case when costs are 83.82 mkr.)

As soon as the first coalition has been formed and agreement has been reached as to the allocation of the total costs of this coalition among its members, they register the coalition with the game director. He will then record the names of the coalition participants, as well as the payment each of them would make toward the total costs of the coalition. Once a coalition has been registered, its content, i.e. the participants and the cost allocation, is announced to all participants of the game.

A coalition does not come into force, however, until 15 minutes have elapsed since its registration, and then only provided that none of its members has been registered in another coalition during this period. Hence a player can leave one coalition and join another in order to decrease the amount of his payment. Furthermore, a coalition dissolves by registering a new coalition with additional members. For new coalitions, the rule still applies that it does not come into force until it has been registered unchanged for 15 minutes.

If the players of a coalition before these 15 minutes have elapsed still want to remain in the game, they can do so by once more registering the same coalition as previously. The players will then remain in the game for at least another 15 minutes.

Once a coalition has come into force, each of its members confirms with the game leader that his municipality is willing to pay the amount agreed upon at the time of the registration. These participants then cease to take an active part in the game, but may remain at the table if they wish to do so.

The game continues in this way until all participants are members of a coalition which has come into force (with the possible exception of a single "leftover" participant). Should the game continue more than 90 minutes from the time of its start, it will be brought to an end and those coalitions registered (but not broken) at the time will come into force.

Finally, it should be stressed that the aim of the game is to shed light on how municipalities negotiate in the field of water resources and what would be reasonable cost allocation models in this area. Hence it is important that you try as much as possible to act as one could expect a representative for a municipality to act during such negotiations where the economic interest of the municipality are at stake.

A prize will be given to that player who according to the judgement of the game leader acts as the most skillful representative for his municipality among the twelve players taking part in the two games.

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