Water Markets Research Group

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A water market with control.

A government water agency runs a constrained auction for big commercial users to lease consent.

We propose to allow trading in the existing administrative right to use water which society has already granted to commercial users, i.e., consent. We do not propose any change in ownership of water. Control of the resource remains with the elected authorities as it is now. The proposal is only for the very large commercial users, and has nothing to do with water for sustenance. Small users, such as city residents, can completely ignore this new system, and would continue to get their water as they do now.

水资源研究小组

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一个受控制的水资源市场

政府的一个水务机构管理一个有约束的拍卖使大型商业用户出租许可。

我们建议，允许在现有的行政管理范围内对使用的水进行交易，即许可，而这种（可以进行交易的）水已经被社会许可为商业用水。我们不建议对水的所有权进行任何变更。和现在一样，资源仍然由经选举的当局来控制。该建议只适用于非常大的商业用户，与持续用水无关。小用户，例如城市的居民，可以完全忽略这个新系统，并且和现在一样，他们将继续取水。

This falls under "full disclosure". I got my MBA and PhD in operations research at the University of Chicago. The Chicago School was a group of economists, who held the view that government intervention is inefficient compared to a free market. While I am not an economist, I have been trained in a free market philosophy. But I don't believe that laissez faire economics can work for water.

I also care deeply about the environment. I bike to work. I drive a Prius. And my personal agenda in this is to **make a better world**, to help build a **practical solution** that will go a long ways toward helping to solve the world water crisis.

I am pro-business and pro-environment.

这属于"完全公布"。我在芝加哥大学完成了MBA和运筹学的博士学位。芝加哥学派包括一群经济学家，他们奉行的观点是，与自由市场相比，政府干预无效。虽然我不是经济学家，但我接受过自由市场理念的教育。但我不相信自由放任的经济学能应用于水资源方面。

我还十分关心环境。我骑自行车上班。我开普锐斯丰田车。而且我的个人目标是建立一个更美好的世界，以帮助建立一个实用的解决方案来长期地帮助解决世界水危机。

我主张商业活动也主张环境保护。

Shared concerns

Business more profitable.
Competitiveness.

Efficiency.
A better environment.

Less contention.

Most controversial:
use a market.

Almost everyone shares the same concerns about New Zealand's water management.

You want to see business more profitable. You want to see NZ more competitive.

✓ You want to see business use water efficiently. You also want to see more certain environmental flows.

✓ You want less contention between the public, businesses, and government.

Any solution must meet the needs of all parties. A purely environmental solution won't work. A purely business solution won't work. Pure government command and control won't work.

✓The most controversial aspect of our proposal is that **we should use a market**. The science is clear about this. We should ignore the economic science no more than we should ignore the hydrological science.

Richard Howitt, of the University of California at Davis wrote "…efficient transfers rely on the detailed local knowledge of water use and value, known only to the ultimate user of the water… The price offered for water condenses a wide range of values and preferences into a single signal that is readily understood and usually persuasive." (Howitt, Calif Ag, 54(2) 2000.)

The question, though, is how to make a market work, especially with complex hydrology .

共同关注的问题

更多的商业利润
竞争力.

效率.
一个更好的环境.

更少的纷争.

最有争议的:
利用市场.

对于新西兰水资源管理，几乎人人都会关注。

√您想看到更多的商业利润。您想看到新西兰更具竞争力。

√您想看到有效的商业用水。您还希望看到更多的某些特定的环境流。

√您想减少公众、企业和政府间的纷争。

任何解决办法必须满足各方的需要。一个纯粹环保化的解决方案将没有效果。一个纯粹商业化的解决方案将没有效果。纯政府指挥和控制将没有效果。

√ 我们应该使用市场，这是我们的建议中最有争议的方面。科学证据是清楚的。我们不应该像对待水文科学一样，忽视经济科学。

在加州大学戴维斯分校的理查德豪伊特写道：“...有效的转移依靠详细地区用水和价值的知识，仅最终的水用户了解这些知识即可... 水的价格将各种价值和偏爱总结成一个容易理解且通常有说服力的单个信号。“（豪伊特，加州农业，54（2）2000。）

不过 现在的问题是如何使市场运行，特别是复杂的水文状况下。

We don't have all the answers.

Consent renewal?

Water charges?

Environmental quantities?

Claw back or compensate?

Has this been done before?

NZ Parliament building

We don't have all the answers.

How are permanent consents renewed? Society must choose. We can provide better tools.

✓ Should gov't charge business for water? Society must choose. Our system works either way.

✓ How much water should be set aside for the environment? Society must choose. Our system allows easier implementation of the decision.

✓ When changes are made to required environmental flows, should government claw back users' rights, or compensate them? Yet again, our system works either way, and provides a mechanism for doing either one.

✓ Where has this been done before?

It's **new**. *Similar* markets are working for many other commodities, including electricity, natural gas, transportation, and radio spectra, with a thousand times higher reliability, security, and data precision requirements than would be needed for water.
It could easily be tried in just one catchment as a test. But honestly, to my knowledge, no one is doing this anywhere in the world.

我们没有所有的答案

延续许可?

水费?

环境量?

追回还是补偿?

这有先例吗?

新西兰国会大楼

我们没有所有的答案。

如何延续永久许可？社会必须选择。我们可以提供更好的工具。

✓政府应该对水资源的贸易收费吗？社会必须选择。不管怎样，我们的系统都有效。

✓我们应该给环境预留多少水呢？社会必须选择。我们的系统可以更容易地执行这个决定。

✓ 当改变了必要的环境流量，政府是应追回用户的权利，还是补偿他们呢？同样，不管怎样，我们的系统都有效，并给任何一种选择提供了一个运作机制。

✓哪里有前例？

这是新的。类似的市场正在为许多其他商品服务，包括电力、天然气、交通运输和无线电频谱，这些市场的可靠性、安全性和数据精度比水所需要的要求高上千倍。

它可以很容易地在一个流域里进行测试。但老实说，就我所知，目前在世界上没有任何人这样做。

Typical questions

Privatisation? Water is owned by the government.
Trade permission to use.

Social values, environment?
Simulate every take, every week,
to ensure environmental flows.

Market power? "Free for all"?
Unlikely. Spatially distributed resource, many users.

Control of the resource?
Water agency controls the market.

Push out small users? Maybe.

Bad data? Maybe, but use data better.

Cheaters? Need the rule of law.

www.teara.govt.nz/en/bird-migration/3/3/1

Doesn't this privatise water? It's NOT privatisation. Water is owned by the government. Only the administrative permission to use water is traded.

✓ **Does our system ignore "social" values?** Won't the environment get hurt? No – they are constraints. Non-commercial water is not for sale. The system simulates every take, for every future week, to ensure the environmental flows.

✓ **What about market power?** Won't the rich will get all the water? For a monopoly, someone would have to buy all the land. A user is likely to get monopoly power only over their own well. A typical catchment has many users, so pricing will probably be competitive. It's NOT "free market" nor "just a free for all". It is a **smart market**, a market with control, with water flows & accounting done by a computer, controlled by the government water agency.

✓ **There's no control of the resource.** False - Water agency retains complete control. Water agency tells every user how much to take, every week. And users will be glad they do.

✓ **Will small producers be pushed out?** Maybe. Depends on their ability to use water effectively. But this is NOT about slamming poor people with high water charges. Intended for the large commercial users.

✓ **It won't work due to bad data.** Same with current system. Not even perfect data can resolve contention! Our system uses existing data much more effectively.

✓ **What if people cheat?** Yes, but this is true of the current system. We need to enforce the law, and use water meters. Now let's look at the problem that our system solves.

典型的问题

私有化？政府对水资源拥有所有权。

使用贸易许可。

社会价值，环境？

模拟每星期的每次取水以确保环境流量。

市场的力量？ "全部自由"？

不太可能。空间分布的资源，许多用户。

控制资源？

水务机构控制市场。

排挤小用户？也许。

不良数据？也许，但使用更好的数据。

骗子？需要法治。

www.teara.govt.nz/en/bird-migration/3/3/1

这难道不是将水私有化？这不是私有化。水归政府所有。只有行政许可使用的水可以进行交易。

✓**我们的制度是否忽视了"社会"价值？**环境会不会受损？不 - 它们是制约因素。非商业性用水不能出售。该系统模拟未来每周的每一次取水，以确保环境流量。

✓**市场权力如何**？富人会不会得到所有的水？对于一个垄断（市场），必须有人购买所有的土地。一个用户很可能只拥有自己水井的垄断权。一个典型的流域有很多用户，因此定价可能将有竞争力。这不是"自由市场"也不是"一个混战"。这是一个智能市场，一个有控制的市场， 由政府水务机构控制，并由电脑来完成水流量和会计事务处理。

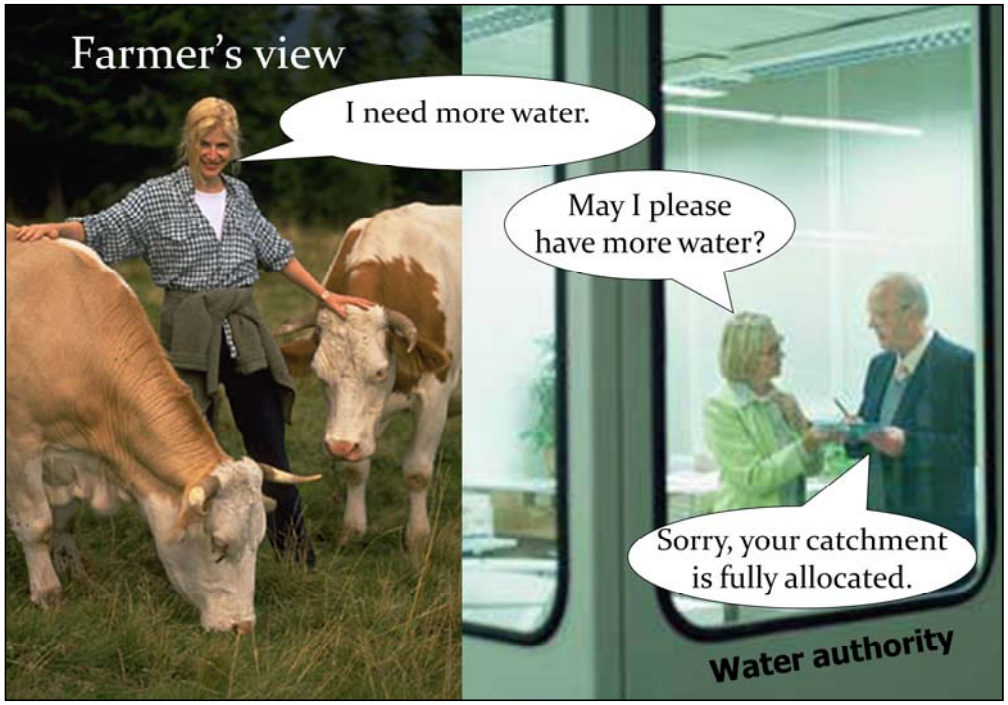
✓对资源没有控制。错 - 水务机构保留完整的控制权。水务机构告诉每一个用户每周取多少水。用户会乐意他们这样做。

✓ 小型生产者将会受排挤吗？也许。取决于他们能否有效地使用水资源。但是这不是以高水费来打击穷人。这针对大型商业用户。

✓ 它会由于错误的数据而停止工作。这与当前系统相同。即使是完美的数据也不能解决纷争！我们的系统以更有效率的方式使用现有的数据。

✓ 如果人们作弊呢？是的，但是对于当前的系统来说，这是真的。我们需要加强法律，并使用水表。现在让我们来看看我们的系统解决的这个问题。

http://www.teara.govt.nz/en/bird-migration/3/3/1



This is Ann. She raises cows. She has an allocation for water, but has decided that she needs more water. Ann is in for a long fight.

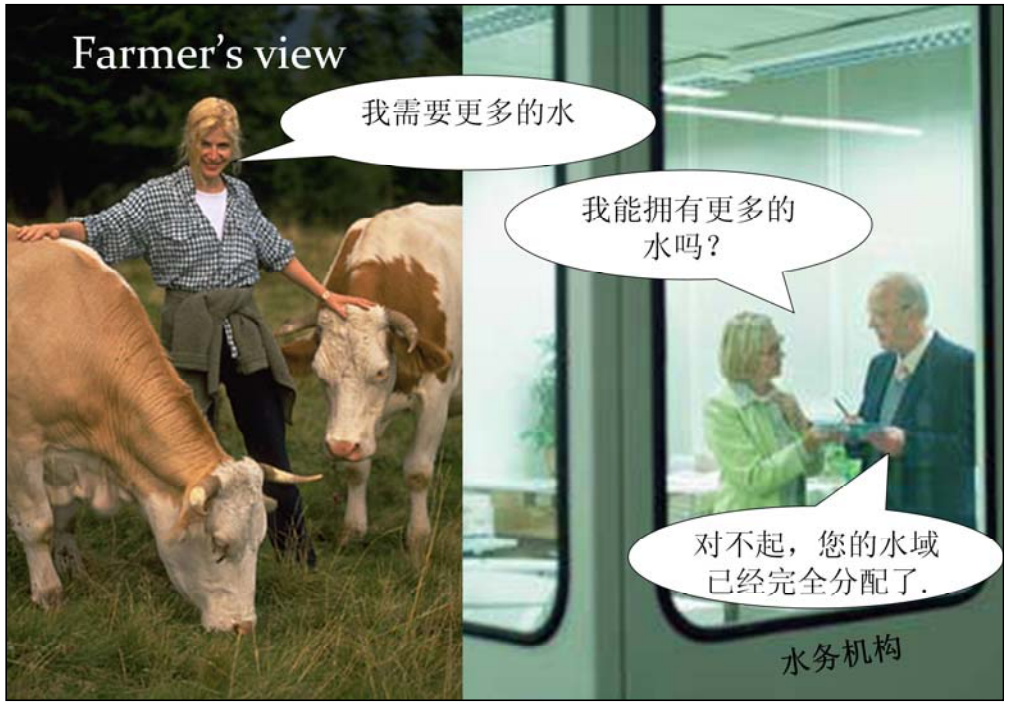
Why is water allocation so difficult? The problem with water is that it is shared, and each person's use affects many other people and the environment. Therefore, society has appropriately arranged for government to manage the commons, and this is reasonable. So government has to be involved with every transaction. This process takes considerable time and cost for all concerned.

First, Ann will go to government with an application. In New Zealand, this application process typically takes several months, and costs thousands of dollars. Ann will have to fill in lots of forms, and probably get a lawyer. This problem is this big transaction cost.

✓

The outcome is not at all certain, no matter how much money she is willing to pay. If the government won't give her water, perhaps she can find someone who will *sell* water to her.

So Ann sends email to all her friends and family, puts up posters in the local pub, and even ads in the paper. Eventually, she finds someone who may be interested in selling her some water.

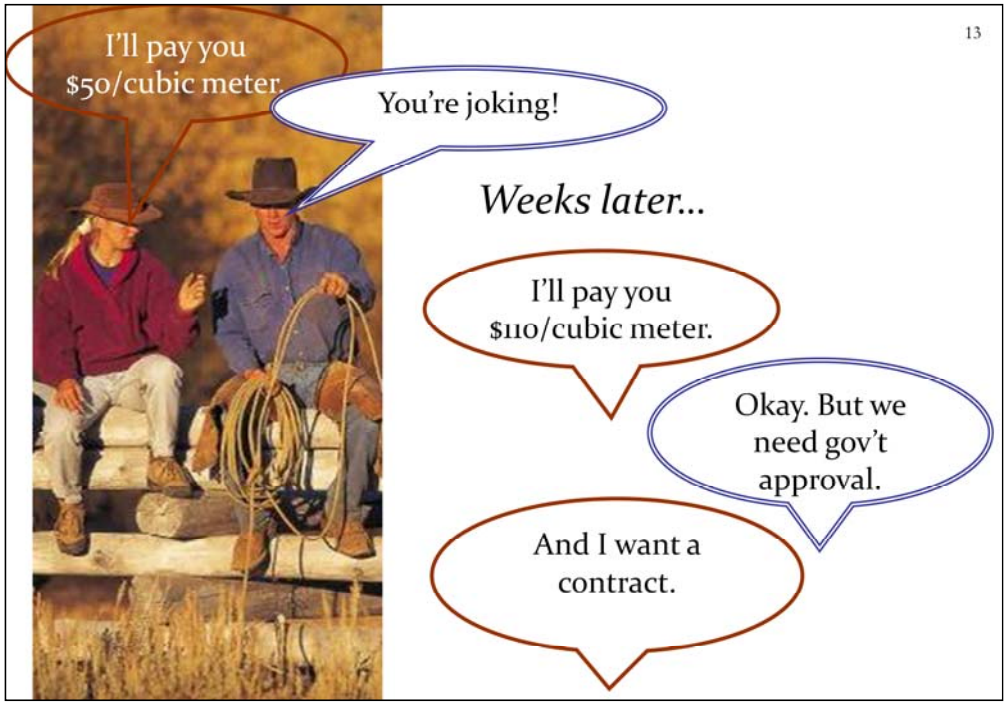


这是安。她畜养奶牛。她拥有水的配额，但她发现她需要更多的水。安卷入了长期的对抗中。

为什么水资源的分配这么困难？水资源的问题是，它是共同的，而且每个人的使用影响到许多其他人与环境。因此，社会也合理地安排政府来管理这些公共资源，而且这是合理的。因此，政府必须参与每一项交易。这个过程需要花费有关各方大量的时间和成本。

首先，安将带着申请去政府。在新西兰，这一申请过程通常需要几个月，数千新西兰元的费用。安将要填写很多表格，可能需要一个律师。问题就在于这个高昂的交易成本。
无论她愿意付多少钱， 最后的结果都是不确定的。如果政府不给她水，她或许可以找那些愿意卖水的人买水。

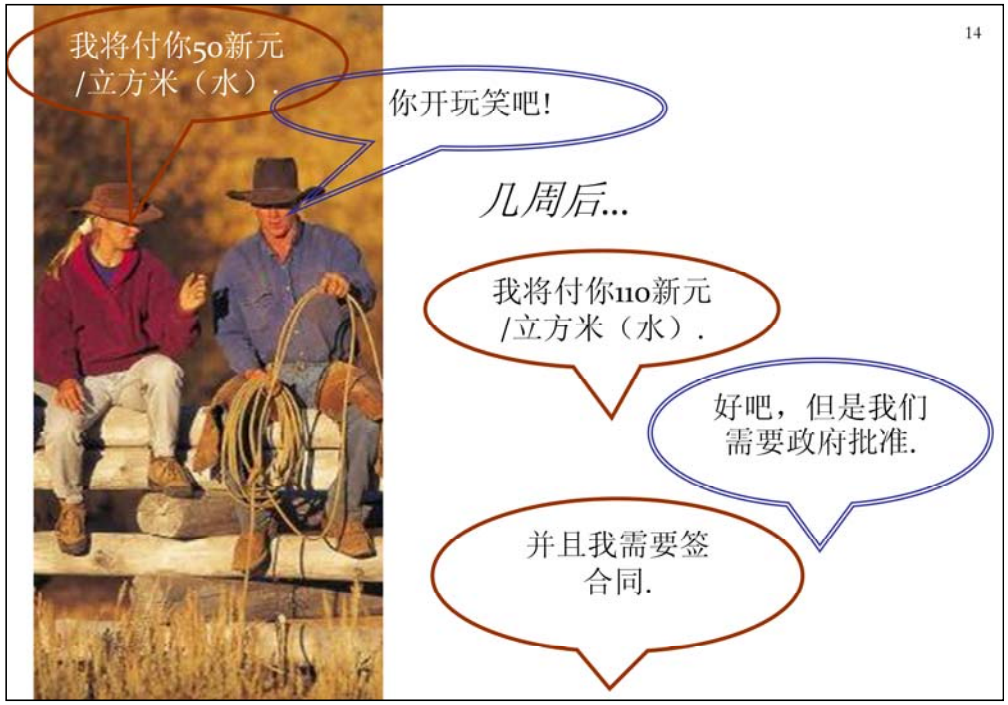
因此，安给她所有的朋友和家人发送电子邮件，在一些当地家酒吧张贴海报，甚至在报纸上刊登广告。最终她找到了一些对销售水感兴趣的人。



This is Ann with her neighbour, Bob. Ann figures that she will pay Bob to take less water, so she can take more water, and it will balance out. After weeks of negotiating, she finally comes to agreement with him.

✓They have to get lawyers, write a contract, work out what to do if the other does not fulfil their end of the deal. And they still have to get government approval.

So Ann has searched for a trading partner, negotiated a deal, written a contract, paid a lawyer, and still has to go to government for approval. The transaction cost is getting bigger.



这是安与她的邻居鲍勃。安猜想如果她支付鲍勃一定的费用以便鲍勃取少取些水，这样她可以取更多的水，而且这样取水量会平衡。几周的谈判后，他们终于达成了协议。

他们得请律师，写一份合同，制定出违约条款。他们仍然需要得到政府的批准。

因此，安一直在寻求贸易伙伴，达成了一项协议，拟了书面合同，支付了律师费用，还需要得到政府的批准。交易成本越来越大。

So Ann and Bob go together to the water authority. They explain what they want to do, and ask for approval.

Of course, everyone's use of common resources affects everyone else, so it is appropriate that government has a role in managing the commons.

At this point, government should look at the hydrology.

http://www.perrypubliclibrary.org/images/meeting-full-full.jpg.

因此，安和鲍勃一起去水务管理机构。他们解释他们想做的事情，并要求批准。

当然，每个人使用公共资源都会影响其他人，因此由政府来管理公共资源比较合适。

在这一点上，政府应该了解水文方面情况。

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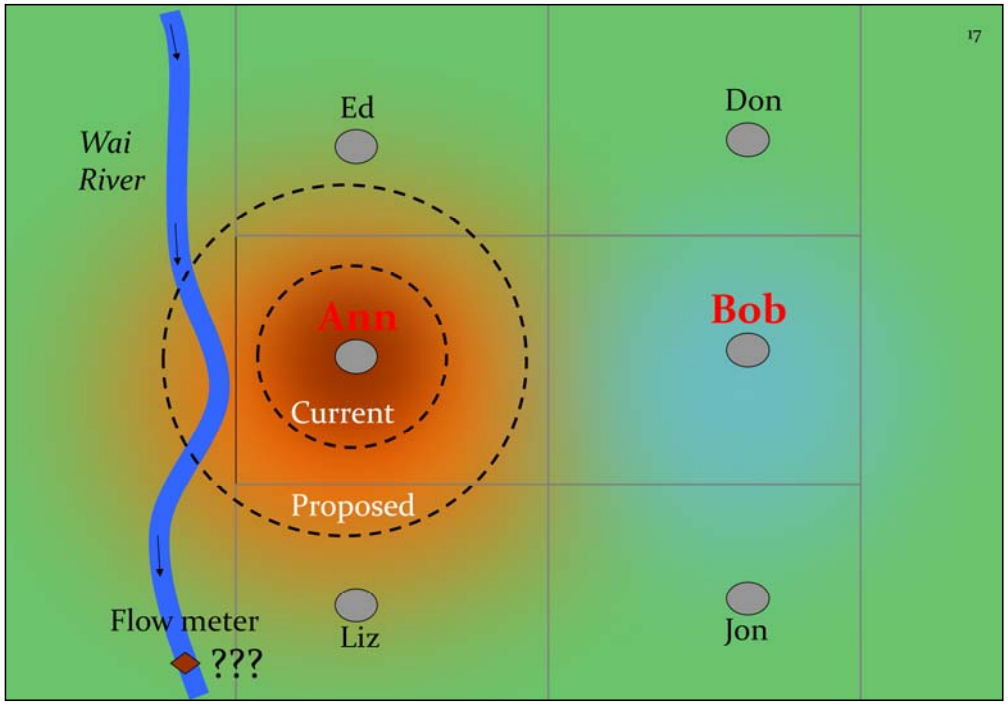
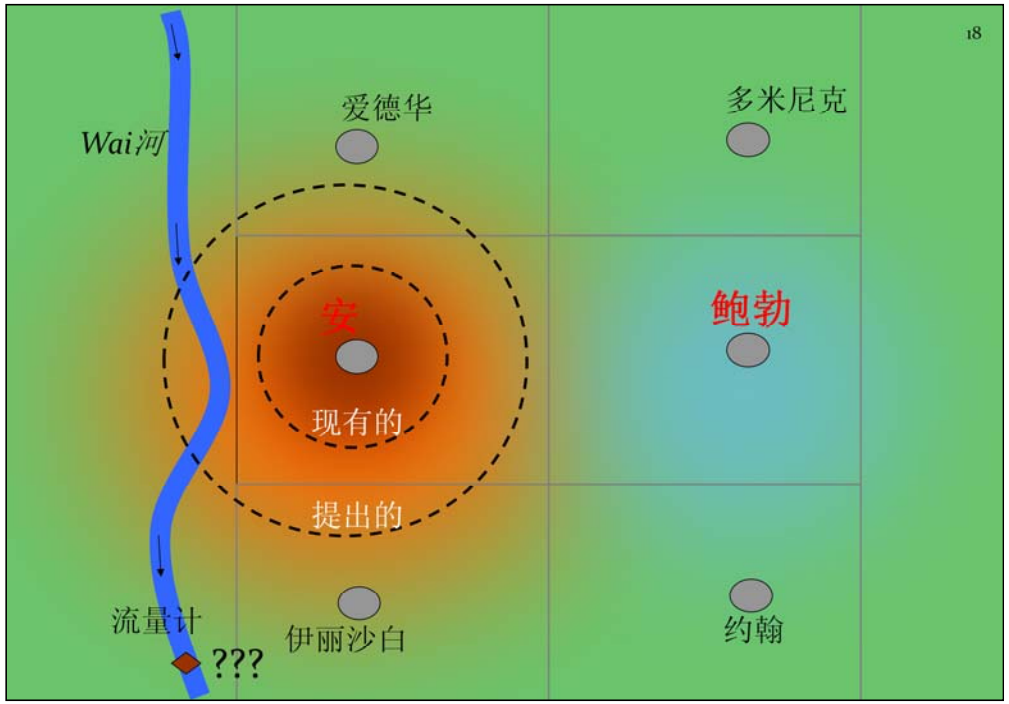


The government hydrologist observes that Ann's well is close to the river, and Bob's well is far from the river. With the proposed trade, Ann will take much more water from the river, even if Bob stops taking water completely. The trade would hurt the environment, as measured at the flow meter. Also, Ann's increased consumption will encroach on Ed and Liz. So the government hydrologist says no.

But the government hydrologist also says – "Oh, it could work, if *all other* farmers in this catchment cut down their water use, especially Ed and Liz," but that would require Ann to make deals with every other farmer in the catchment. This is too hard for Ann.

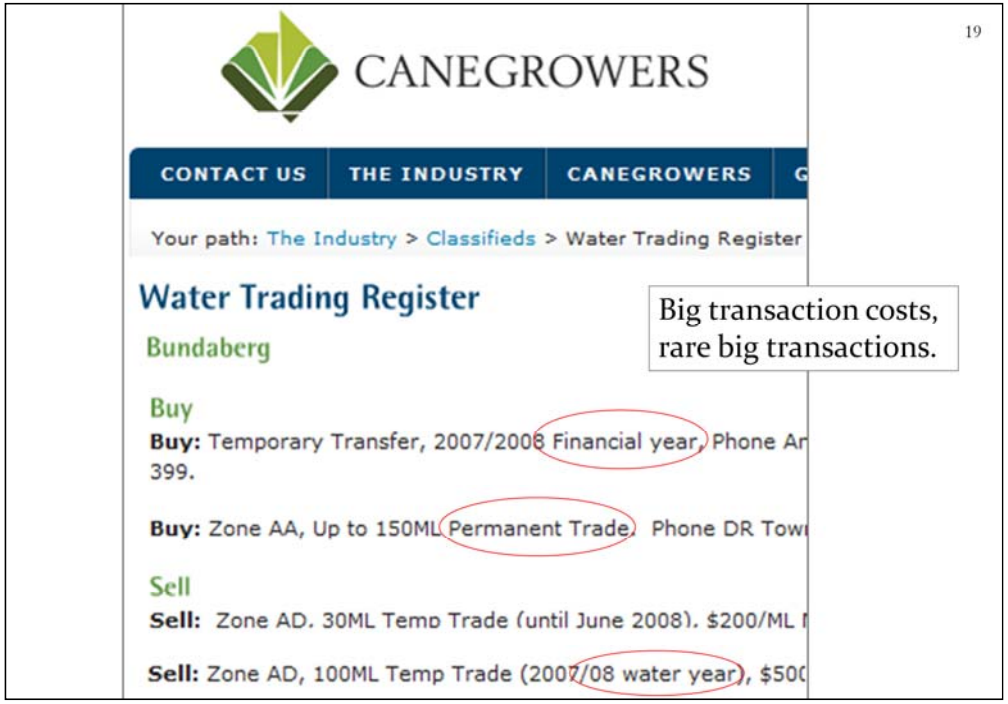
By now, Ann and Bob have invested so much in this deal, that they just can't afford to let it fail. Since the river level is highly uncertain, they take their case to court. The transaction cost just keeps getting bigger.



政府的水文学家认为，安的水井靠近河流，鲍勃的水井远离河流。根据该交易提议，即使鲍勃完全停止取水，安也会从河里取更多的水。流量计测量表明，这项交易会损害环境。此外，安增加用水消耗将影响爱德华和伊丽沙白。因此，政府的水文学家说"不"。

但政府的水文学家也说 - "哦，如果集水区的其他所有农民，尤其是爱德华和伊丽沙白减少他们的用水，那么这个想法是可以运作的"，但这将要求安和该流域的其他每个农户做交易。对于安来说这很困难。

截至目前，安和鲍勃已在这次交易中进行了大量投资，他们不能让交易失败。由于河流的水位是高度不确定的，他们将其案件提交法院审理。交易成本会越来越大。



This Australian bulletin board lowers one part of the transaction cost, the search. Notice the long term lengths – for the financial year, a permanent trade, for the water year. Trades are big and happen rarely, in a dry country that has worked hard to allow water trading.

Some people, even some economists, think that water trading will magically happen, simply if it is allowed. People trade contraband because they want to, even though government forbids it. Transaction costs for trading marijuana and P are small. But almost no one trades water, even though they badly want to, and even though government allows it. The transaction costs for trading water are just too big.

For surface water, traders can be matched nearly one-to-one, because the water is controlled. World wide, water markets are active primarily when water is controlled with reservoirs and canals. Hence, water users love expensive solutions of steel, concrete & pumps, especially with government subsidies. But they *still* have high transaction costs.

And not just in New Zealand, but world-wide. In fact, New Zealand is far better at managing water allocation than most countries, with greater transparency and honesty, and much stronger instutitions. The problem of high transaction costs is **no one's fault**, but rather is an inherent problem of managing a complex shared resource.

These transaction costs occur for *everyone* who wants to change water allocations, not just farmers. Utility companies, environmentalists, and government all face these large transaction costs. If government wants more water for the environment, government faces a contentious process in "clawing back" water from users. Even if government were willing to pay users to give up water, no process for such payment exists. So government has big committees that make crude decisions once every decade or so. So that's the basic probem of water allocation. Now let's see the benefits if Forever Fair were implemented.

这个澳大利亚布告栏可以降低一部分交易成本，搜索部分。注意时间长度- 财政年度、一个永久交易、水年。在一个水资源不足，但努力实现水贸易的国家里，贸易额很大但是发生频率低。

有些人，甚至一些经济学家认为，只要被允许，水贸易会奇迹般地出现。尽管政府禁止，人们仍然进行走私交易，因为他们想这样做。大麻和其他非法毒品的交易成本很小。但是，即使人们很想进行水的交易，且政府也允许，但几乎没有人这样做。仅仅因为水的交易成本太大。

至于地表水，交易者几乎可以一对一地匹配，因为地表水受到控制。在世界范围里，当水受水库和运河调控时，水市场比较活跃。因此，水用户喜欢昂贵的解决方案，比如钢铁，混凝土及水泵，特别是当有政府补贴时，更是如此。但是，他们仍然有较高的交易成本。

而且这不只是在新西兰，在世界各地也是如此。事实上，新西兰在管理水资源分配上比大多数国家做得好，因为新西兰有更大的透明度和诚信度，以及更强大的机构。高交易成本问题**不是任何人的过错**，而是管理一个复杂的公共资源的固有问题。

任何想要改变水配置的人都会面临这些交易成本，而不仅仅是农民。公用事业公司，环保人士和政府都面临着这些巨大的交易成本。如果政府希望给环境更多的水，那么政府面临一个从用户"扣回"水的争议过程。即使政府愿意付钱让用户放弃使用水，也并不存在这种付款程序。因此，政府拥有大量的委员会，他们每10年左右做出基本的决定。所以，这就是水分配的基本问题。现在让我们看看如果"永远公平"被实施的好处。

Benefits of Forever Fair

Make money in every trade.

Your fishing spot protected.

Gov't responsive,
not the enemy.

www.banknotes.com/NZ161.JPG, www.newzealandnz.co.nz/methvenmthutt/fishing.jpg

What are the benefits of our system?

Users make money in every trade. You can sell excess consent, or get water for production. This co-operative approach reduces risk. Participation is voluntary.

There is public data on water prices. Users & gov't can make better decisions about investment.

✓ **Your fishing spot is protected.** The system guarantees environmental flows at every auction. It responds in real time to environmental changes. **State-of-the-art approach**. It is unique world-wide in its complete combination of physics , economics, and sustainability.

✓ Gov't looks **responsive, impartial & fair.** Gives **opportunity**, not rigid rules. Gov't *enables* the market, while ensuring environmental flows. Over-allocated catchments become perfectly allocated, in near real time, under complex hydrology, and uncertain future flows, forever. No need to try to make artificial judgements about who "should" get water.

Simple **pay-for-itself mechanism**, a small commission on each trade. Hydrology modelling **investment is put to active every-day use**.

We can't make it rain, but we can do a much better job of allocating the available water.

www.banknotes.com/NZ161.JPG, www.newzealandnz.co.nz/methvenmthutt/fishing.jpg

永远公平的好处

每次交易都盈利

您的鱼场受到了保护

政府回应，不是对手

www.banknotes.com/NZ161.JPG, www.newzealandnz

我们的系统有哪些好处？

用户在每次交易中都盈利。你可以出售多余的许可，或获取生产用水。这种合作的方式降低了风险。自愿参与。

有关水的价格存在公共数据。用户和政府可以作出更好的投资决策。

✓

您的钓鱼场受到保护。该系统保证了每次拍卖的环境流量。它实时地响应环境变化。**最先进的方法**。物理学、经济学和可持续性完整的结合使它在世界范围内都很独特 。

✓

政府看起来**反应灵敏、公正和公平**。提供机会，而不是硬性规定。政府在确保环境流动的同时能使市场运作。不久，在复杂的水文和不确定的未来流量情况下，过度分配的集水区将永久性地分配得恰到好处。无需设法作出谁"应该"得到水的人为决定。

简单的**自己支付**的机制，每一次交易只需少量的佣金。水文模型的**投资在每天应用中都很活跃**。

我们不能控制降雨，但我们可以在调配现有的水资源方面做得更好。

www.banknotes.com/NZ161.JPG, www.newzealandnz.co.nz/methvenmthutt/fishing.jpg

Higher value of water from more productive use

!

Of course, a key benefit is the immediate improvement in the efficiency and productivity of one of New Zealand's most important assets.

[Pause]

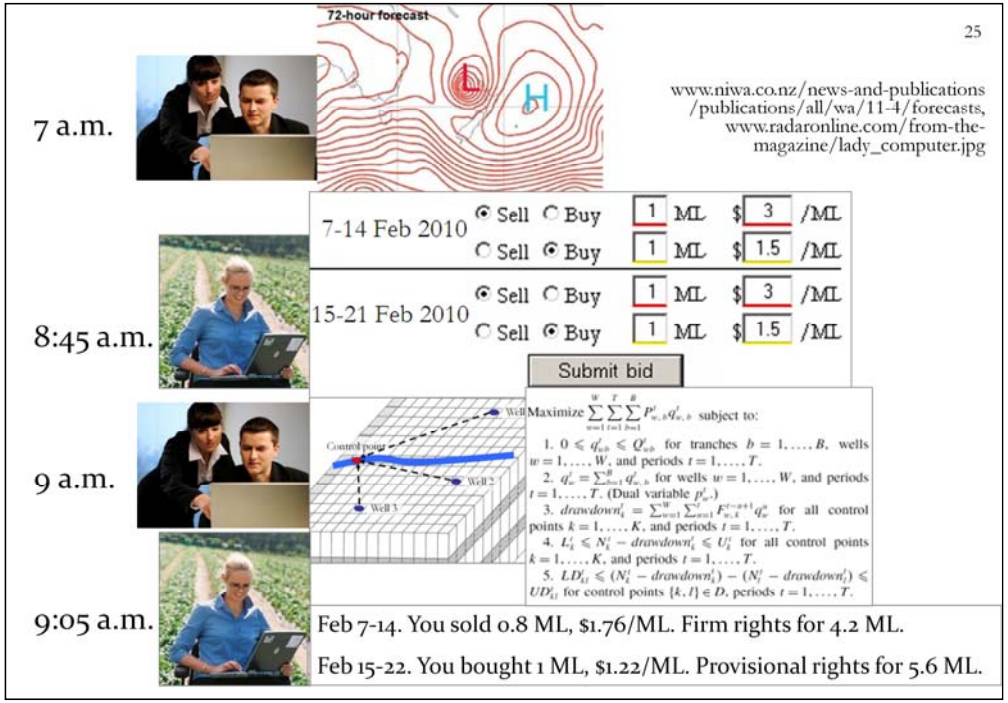
And the lawsuits go away! Which is easier: going to court, or **clicking on a web site**?

通过更有效地使用来提高水的价值

!

当然，一个关键的好处是，新西兰最重要的一个资产的效率和生产力得到了立即的改善。

[暂停]
诉讼请走开！哪个更容易：去法院，或在网站上点击？



Here's the auction process, once per day or once per week.

1. A **market manager** serves as a broker. To ensure that environmental constraints can be met, the manager may reduce consents proportionally. Here, we see the market manager checking the weather before the auction, to calculate the available water.

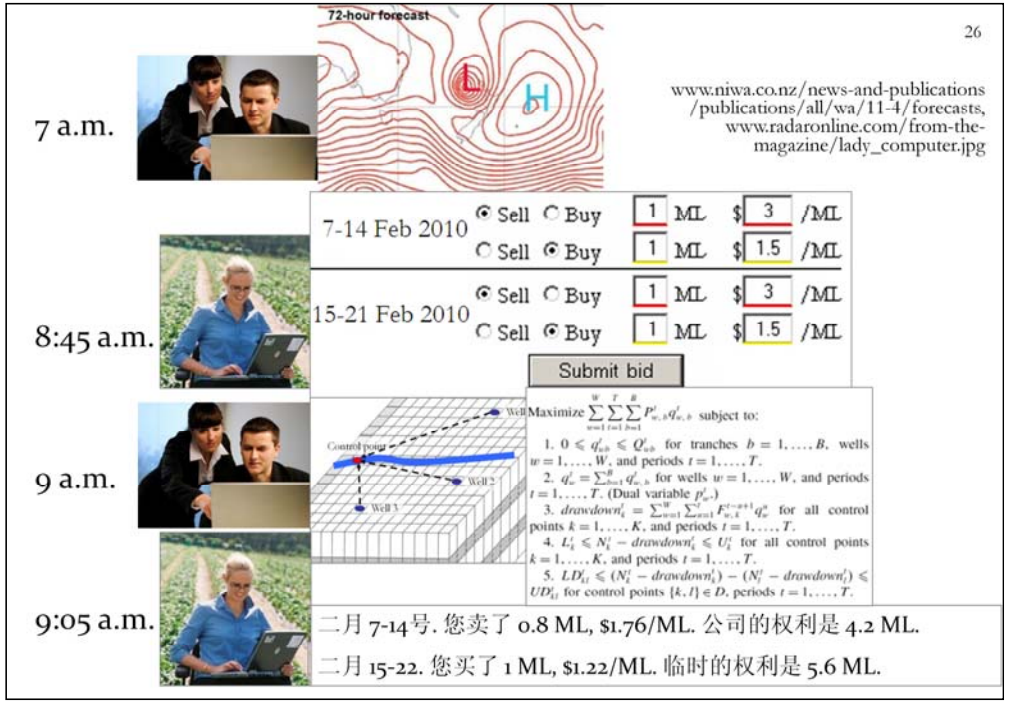
✓ 2. Ann logs onto the secure encrypted auction website, before 9 a.m. Monday. She has an **initial net consent** as a result of previous auctions. If Ann doesn't go on the website, she can still take her initial consent for free. Bids are **changes** to consent. A user can bid to sell for a high price *and* buy for a low price. Ann makes several bids at once. She will sell for a high price, and would buy for a low price. Critically, she can bid for water rights for future weeks in this week's auction, thus lowering her risk. So right now, she can change her full production plan, for every week in the remainder of the year, if she wants to. Ann's bids are private. Only she and the market manager can see them.

✓ At 9 a.m., bidding closes. Based on the bids, hydrology, and environmental constraints, the manager runs a **hydrological optimisation**. The computer model allocates all water in the catchment at once, for every remaining week in the hydrological year, taking into account expected future effects. The model calculates market-clearing prices following standard theory, and ensures environmental flows.

✓ The market manager announces allocations and prices at each well. These prices are public information. Each user's allocation becomes their **new consent for that period**. The auction manager updates Ann's web page with her allocation & price, and charges or pays her, if she has bought or sold. She now has firm rights to take water for this week, and provisional rights for water in future weeks.

No infrastructure is needed! We don't need reservoirs to trade water. We just need a reasonably good hydrology model. This is a water market with control.

http://www.niwa.co.nz/news-and-publications/publications/all/wa/11-4/forecasts,
http://www.radaronline.com/from-the-magazine/lady_computer.jpg



这是拍卖过程，每天一次或每周一次。

1. 一个市场经理充当经纪人。为确保环境的限制能被满足，管理者可以按比例减少许可。在这里，我们看到市场经理在拍卖前通过检查天气，来计算可以利用的水。

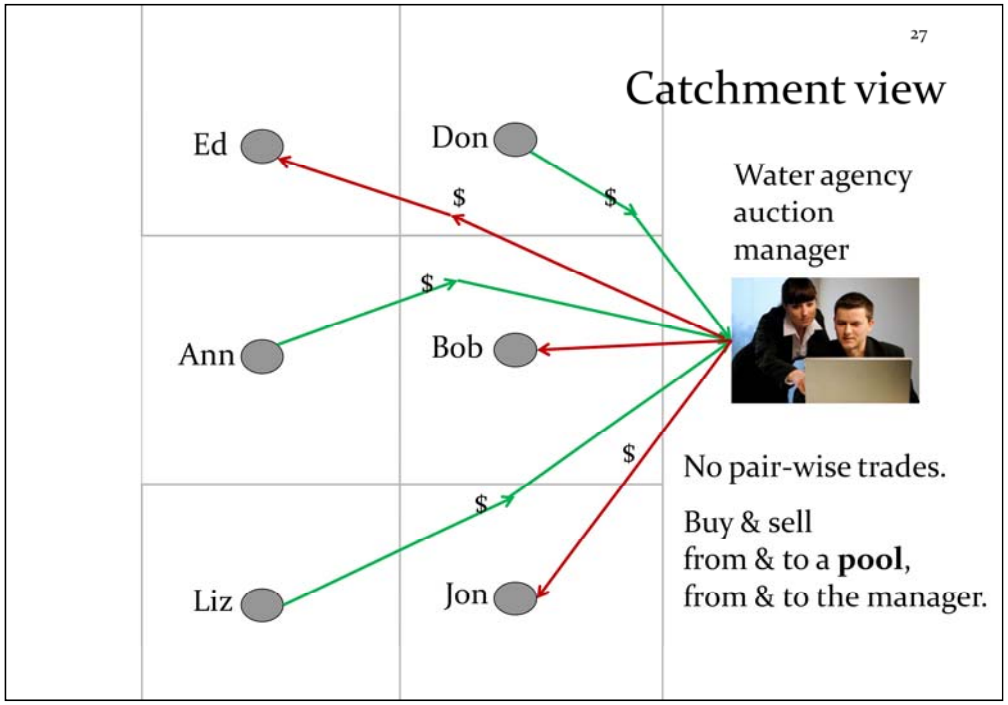
✓2.安在星期一上午9时前登录到安全加密的拍卖网站。通过以前的拍卖她已获得**初始净许可**。如果不进入网站，她仍然可以免费获得她最初的许可。竞标是对许可的**更改**。用户可以以高价出售，也可以以较低的价格购买。安多次同时竞标。她将高价销售，并低价购买。至关重要的是，她可以在本周的拍卖中为未来几周取水权竞标，从而降低了风险。所以，她此时可以改变在今年余下的每星期里的全部生产计划（只要她愿意）。安的竞标属私人性质。只有她和市场经理可以看到它们。

✓在上午9时，投标截止。根据标书、水文、和环境的限制，管理者进行**水文优化**。在考虑了预计的未来影响后，该计算机模型立刻分配该集水区在水文年余下的每星期的水。该模型通过标准理论来计算市场的清算价格，并确保环境流量。

✓ 市场经理宣布有关每口井的分配和价格。这些价格都是公开的信息。每个用户的配置成为他们为**这一时期的新许可**。拍卖会经理更新安的网页上的分配量及价格，并收取她的费用或者付款给她，如果她已经购买或出售。她现在拥有坚实的权利在本周取水，并有临时权利在未来几个星期里取水。

不需要基础设施！我们并不需要水库来进行水的贸易。我们只需要一个合理的水文模型。这是一个受控制的水资源市场。

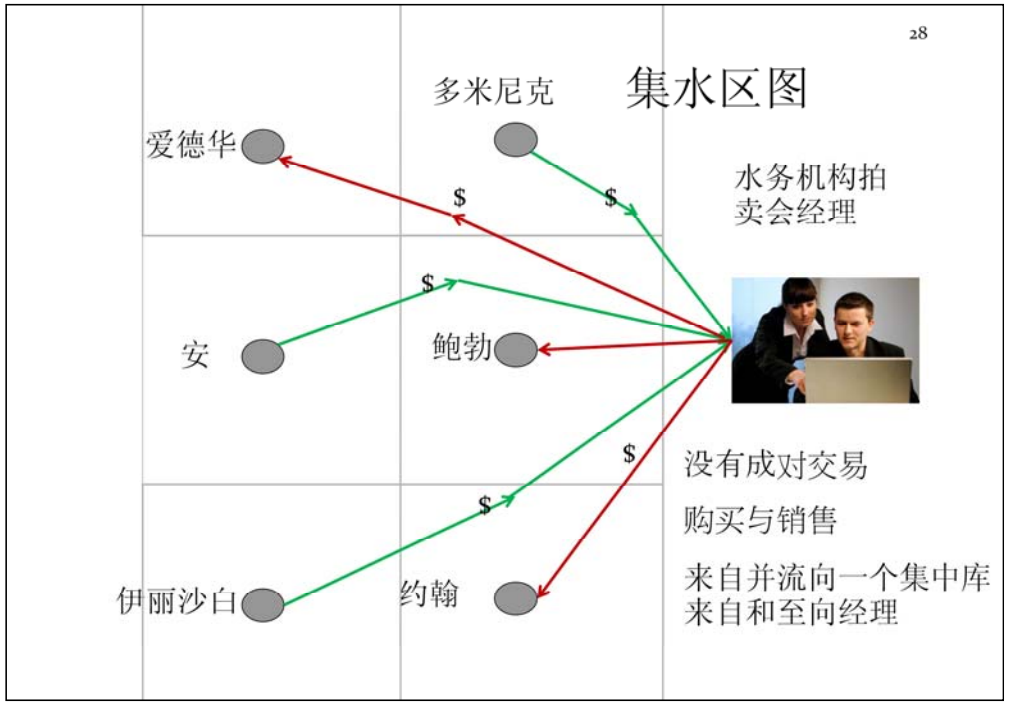
http://www.niwa.co.nz/news-and-publications/publications/all/wa/11-4/forecasts,
http://www.radaronline.com/from-the-magazine/lady_computer.jpg



Here's a catchment view. All water is traded through the auction, as central pool.

And these models are easy! Operations research models are now used heavily by government and industry: crew scheduling at Air NZ, reservoir scheduling for hydrogenerators, census planning at StatisticsNZ, forestry planning, vehicle routing, facility location at Norske Skog, many many applications. These hydrological models are very simple by comparison. It's the politics that's difficult.

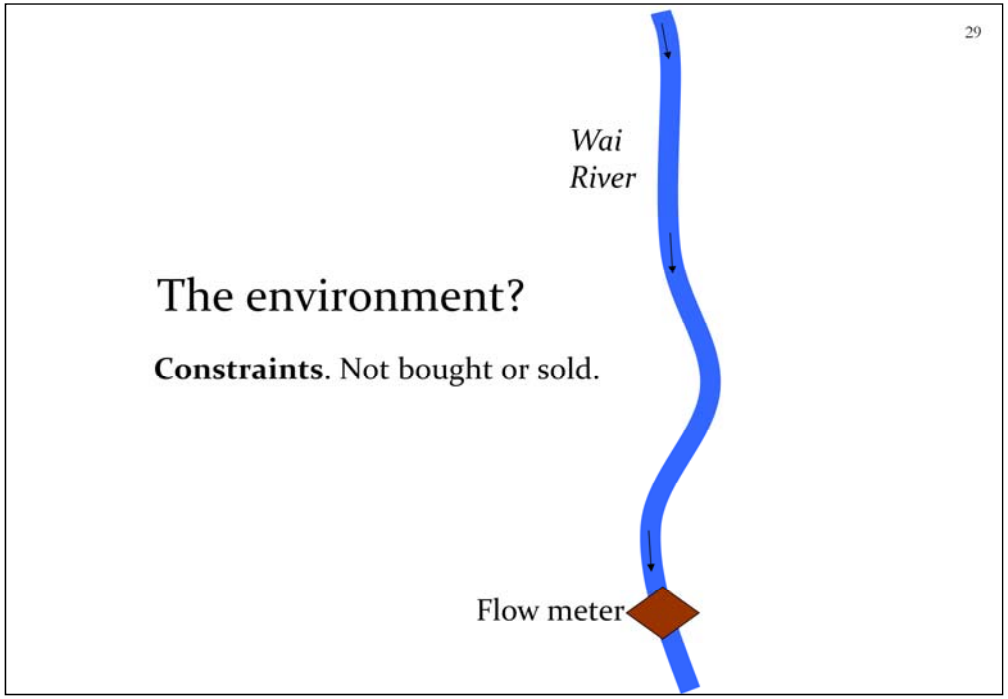
What about the environment, how does it fit in?



这是一个集水区图。作为中心库，所有的水都是通过拍卖进行交易。

而这些模型很容易运作！目前运筹学模型已大量应用于由政府和工业：新西兰航空公司机组人员的工作安排，水轮发电机机组的水库调控，新西兰统计局的普查规划，林业规划，车辆路径安排，诺斯克斯的设施分配，有许多应用。相比之下，这些都是很简单的水文模型。困难的是政治因素。

对于环境又是什么情况，它将如何适应呢？



The environmental flows do not require a price or a bid; they are a constraint under which commerce must operate. This system would ensure that commercial water use never violates agreed-on environmental standards. All flows would be simulated before users were given permission to take water, at every auction. This is the "forever" part of "Forever Fair".

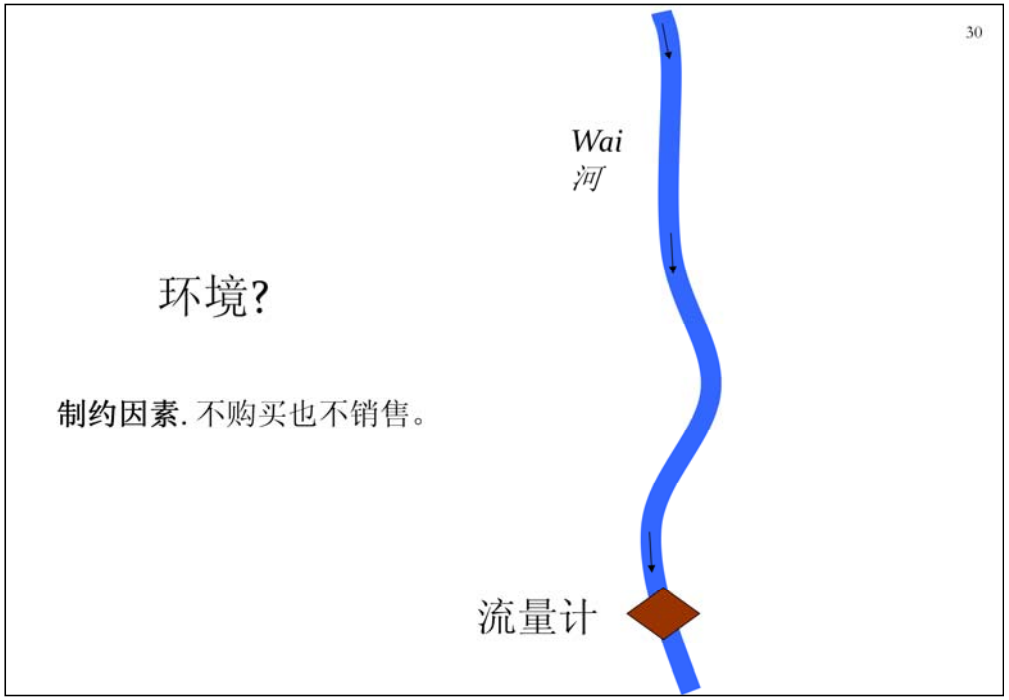
The environmental flows are chosen by gov't & community, with help from hydrologists, just as they are now.

Will a user be penalised for being close to a sensitive region? Yes. Prices will be higher near sensitive places. That's good! We *want* to discourage water use near environmentally sensitive places.

What about the effect of water use over time? Water use now can hurt the environment in the future. The system simulates *future* water flow to prevent future problems. Whether prices are high or low, *even if users collude or monopolize*, these constraints ensure that the environment is protected.

Interestingly, this process allows buying of additional water on behalf of the environment, which anyone could do. An environmental agent could be tasked with buying and selling water rights so as to maximize environmental value subject to a budget. This would improve ecological outcomes drastically at very low cost! Users would be seamlessly compensated at fair prices.

So this is a water market with control. Now what exactly is being traded?



环境流量不需要价格或竞标；他们是商业运作必须满足的约束条件。这一系统将确保商业用水永不违反商定的环境标准。每次拍卖时，在用户被许可取水之前，将模拟所有流量。这是“永远公平”中“永远”的部分。

环境的流量在水文学家的帮助下由政府及社区选择，正如他们现在所做的那样。

如果一个用户靠近敏感地区这是否是他的惩罚？是。因为接近敏感的地方价格更高。这很好！我们不鼓励在环境敏感地区附近使用水。
那么在一段时间内的水使用有什么影响？水的当前使用可以损害未来的环境。该系统通过模拟未来的水流量，以避免未来的问题。无论价格是高还是低，即使用户串通或垄断，这些限制都能确保环境得到保护。

有趣的是，这个过程允许代表环境来购买额外的水，任何人都可以这么做。一个环境代理商可负责购买和出售取水权，来最大限度地在预算范围内提高环保价值。这将以非常低的成本来大大改善生态环境！用户将可以以公平的价格得到合理的补偿。

这是一个受控制的水市场。接下来究竟是在交易什么？

Nature of the right

The right is to take water at a given location,
for a given time period (e.g., a week),
for acceptable use.

Tietenberg, 2002.
"... give 'adequate' (as opposed to complete) security
to the permit holders,
while making it clear that permits
are not property rights."

The right is to take water at a given location, for a given time period (e.g., a week), for acceptable use.

In 2002, Tom Tietenberg wrote an article, called "The Tradable Permits Approach to Protecting the Commons" Here's his comment on rights.

"…give 'adequate' (as opposed to complete) security to the permit holders, while making it clear that permits are not property rights. For example according to the title of the US Clean Air Act dealing with the sulfur allowance program: 'An allowance under this title is a limited authorization to emit sulfur dioxide....Such allowance does not constitute a property right. (104 Stat 2591) In practice this means that administrators are expected to recognize the security needed to protect…[users'] investments by not arbitrarily confiscating rights. They do not, however, give up their ability to change control requirements as the need arises. In particular they will not be inhibited by the need to pay compensation for withdrawing a portion of the authorization to emit as they would if allowances were accorded full property right status. It is a somewhat uneasy compromise, but it seems to have worked."

You can't have a property right to the commons. That means that this approach probably should *not* be left purely to the private sector, at least not without government supervision, because the incentives are wrong, and because the resource is public.

Our system relies on the ability of the environmental authority to scale users' rights to the available water. Let's see some implications of this.

取水权的性质

取水权是在一给定地点、在一个给定的时间段
内（如一周）取水并进行合理使用。

Tietenberg，2002年。"...给许可证的持有人
'足够'"（而不是完整的）的安全性，同
时明确许可证并不是财产权。"

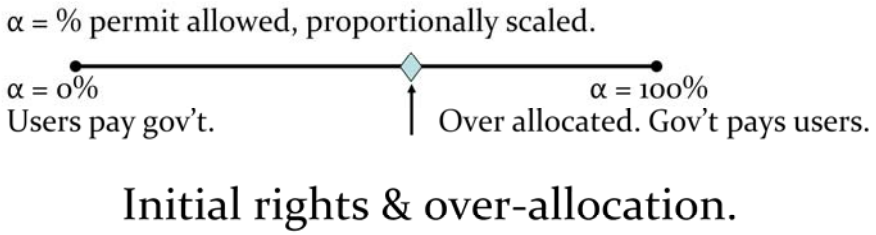
取水权是在某一地点，在一个给定的时间段内（如一周）取水进行合理的使用。

2002年，Tom Tietenberg写了一篇文章叫做"通过可交易的许可证的方式来保护公共资源" 这是他对取水权的评论。

"...给许可证的持有人'足够'"（而不是完整的）的安全性，同时明确许可证并不是财产权。 例如根据《美国清洁空气法案》（处理含硫量许可的项目）的权利：'这项权利下的许可是排放二氧化硫的受限制的授权....这项许可并不构成财产权。（104统计2591）实际上，这意味着管理人员应当承认需要安全性，通过不磨棱两可的没收权来保护... [用户的]投资。然而当这些需求出现时，他们不会放弃他们改变控制要求的能力。特别是，他们不会因需要赔偿撤回一部分排放权而暂停；但如果许可的地位和完整的财产权的地位一致，那么他们会暂停。这是一个有点不稳妥的妥协，但似乎发挥了作用。"

你不能让（任何人对）公共资源有财产权利。这意味着这种做法可能不应纯粹地由私营部门（来管理），至少不能没有政府的监管，因为动机不良，并且资源是公共的。

我们的系统依赖于环境权威来衡量用户对可用水的使用权利。让我们看看一些这方面的影响。



Initial rights & over-allocation.

Alpha is the % permit allowed. So if alpha is 80%, then every user gets 80% of their consent.

✓

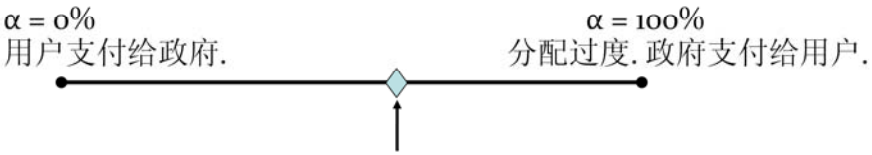
With α = 0%, the market manager is a monopolist, selling water in a user-pays system. Probably not acceptable to users. Unnecessary for efficiency.

With α = 100%, the catchment is likely over allocated (depending on weather conditions). In this case, because the environmental flows **must** be met as constraints, the computer requires the market manager to buy rights from users to protect the environment. This is more like government procurement. This is not a sustainable policy from government's point of view. Users can raise prices to infinity, and gouge taxpayers. Perverse incentives – users holding government to ransom.

What if we could find α where net revenue = $0? That would be a "user trades" system, where the market manager is a revenue-neutral broker.

So the market manager (the government water agency) must have authority to adjust consents to match conditions. The water agency already has such authority, but our system would make this far more precise.

α = % 许可, 这种许可是被允许并成比例地度量.



最初的权利和分配过度.

α 是许可量的百分比。因此，如果α 为80%，那么每个用户得到了他们许可的80%。

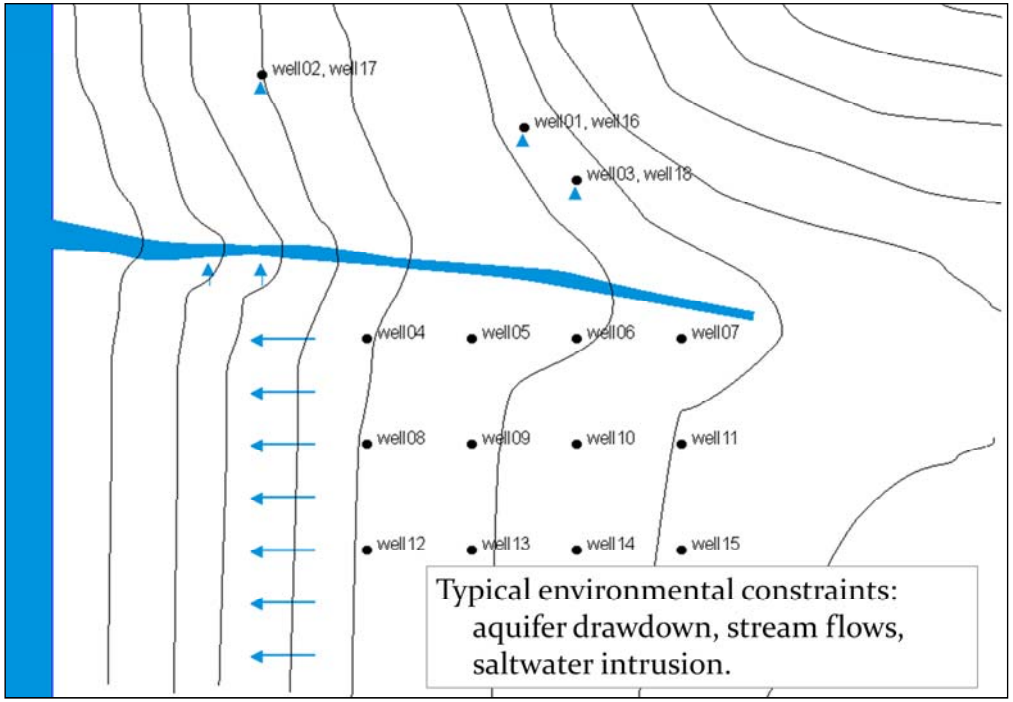
✓

当 α = 0%时，市场经理是一个垄断者，在一个用户付款的系统里销售水。也许不能被用户所接受。对于效率来说这是不必要的。

当α = 100%时，集水区很有可能过度分配（取决于天气状况）。在这种情况下，由于环境流必须作为约束条件得到满足，计算机要求市场经理从用户那里购买取水权来保护环境。这更像是政府采购。从政府的角度来看，这不是一个持续发展的政策。用户可以将价格提高到无穷大，来勒索纳税人。不正当的动机--用户通过政府来牟取赎金。

假如我们能找到一个α使净收入= $ 0，情况将如何？这将是一个“用户交易”系统，其中市场经理是一个收入中立的经纪人。

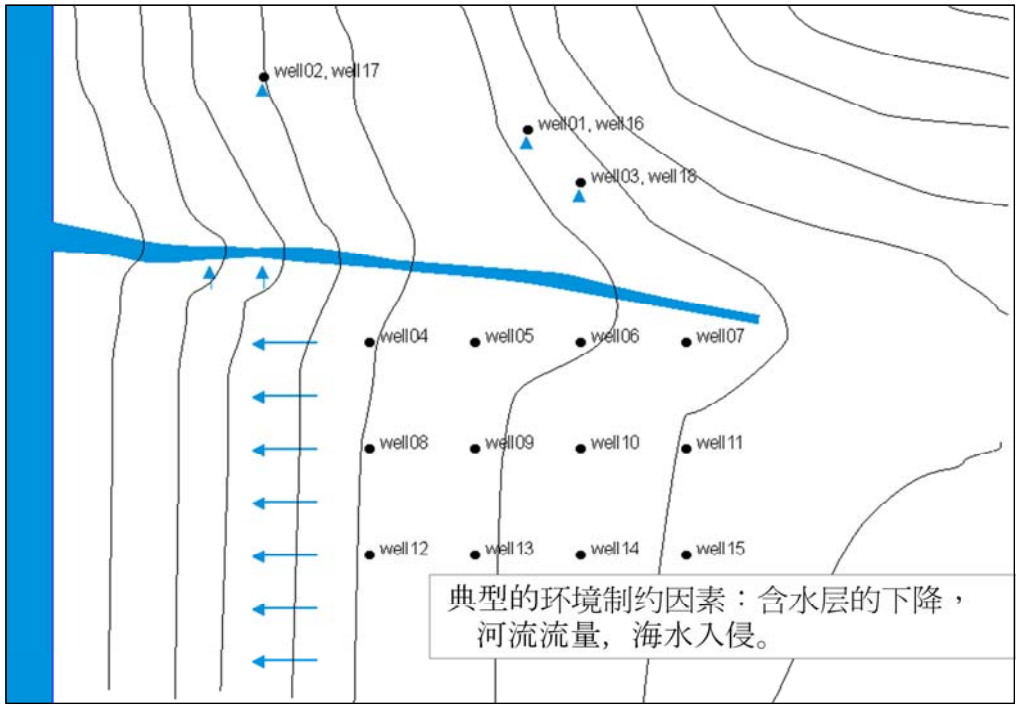
因此，市场经理（政府水务机构）必须有权力调整许可以符合条件。水务机构已经有了这样的权力，但我们的系统将使它更为精确。



This is a schematic of a catchment with 16 wells. The ocean is at left. A stream runs through the middle. The dots are the wells.

The triangles indicate aquifer draw down constraints, that the aquifer may not be drawn down too far. The arrows indicate required head constraints, two to make sure the stream has flow, and seven to prevent salt water intrusion from the coast. The curved lines indicate the natural aquifer height.

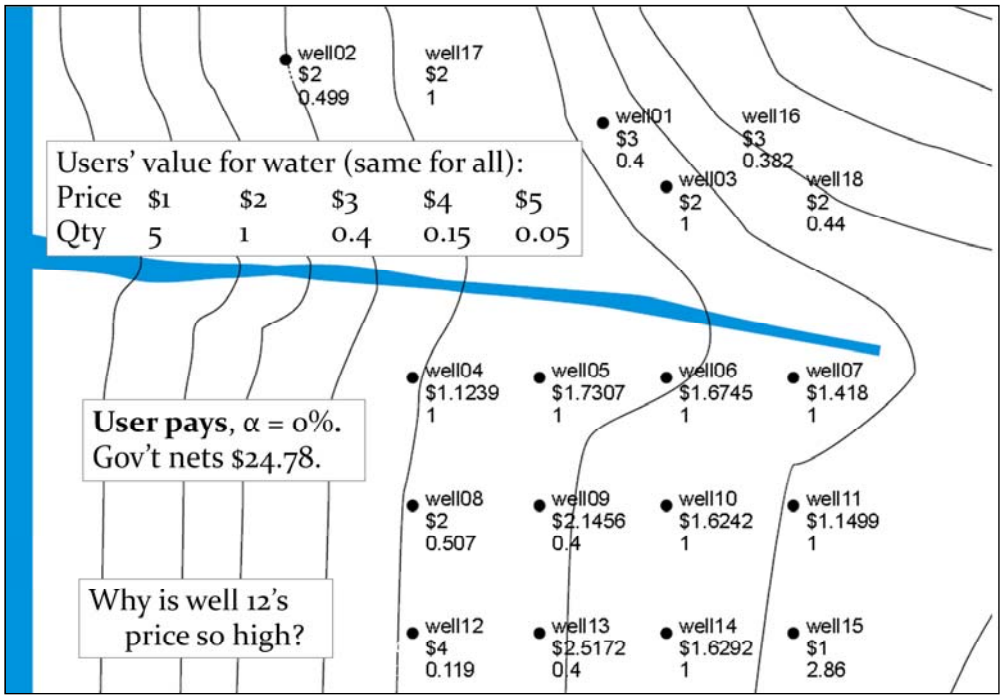
We'll see four scenarios: first user pays, second over-allocation, third proportional reduction, and last a really cool scenario that we call "user trades".



这是一个有16口井的集水区的示意图。海洋是左侧。一条小溪从中间穿过。黑点代表水井。

三角形代表含水层水位下降的限制，即含水层水位不会下降太多。箭头表示必须满足的水位落差限制，2个箭头确保小溪有流量，7个箭头防止海水从海岸入侵。曲线代表含水层的自然高度。

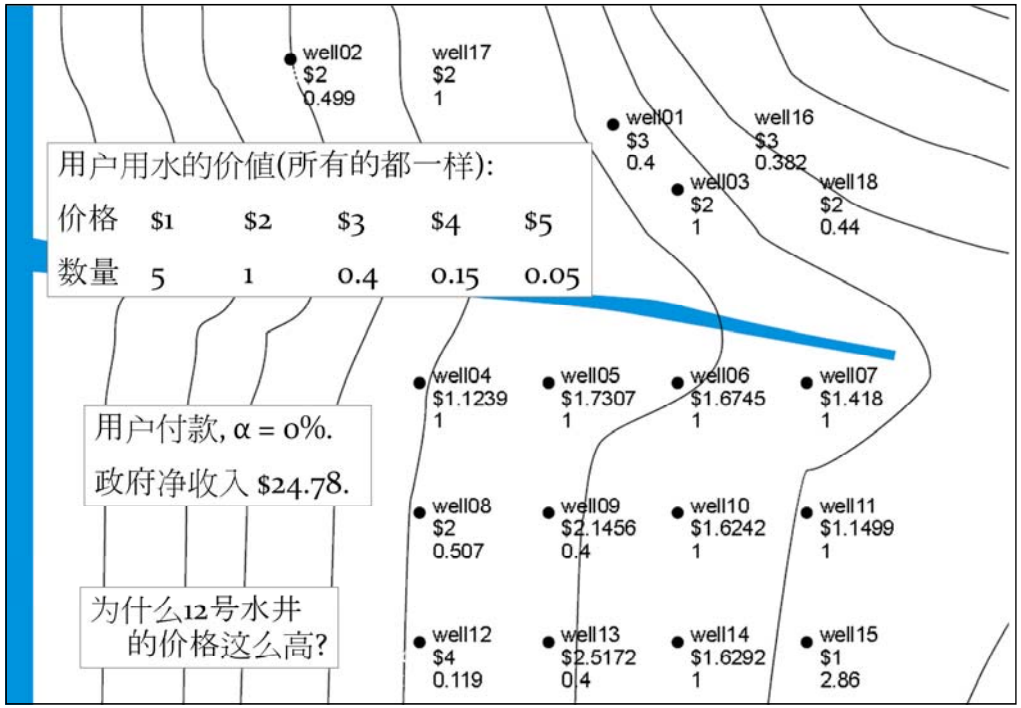
我们将看到四种情况：第一用者付款，第二分配过度，第三按比例减少，最后，一个非常酷的情况，我们称之为“用户交易”。



We assume everyone has equal value for water. Users would sell all their water if the price were more than $5.

In this example, we assume that users have no initial consents, and they must buy it from government.

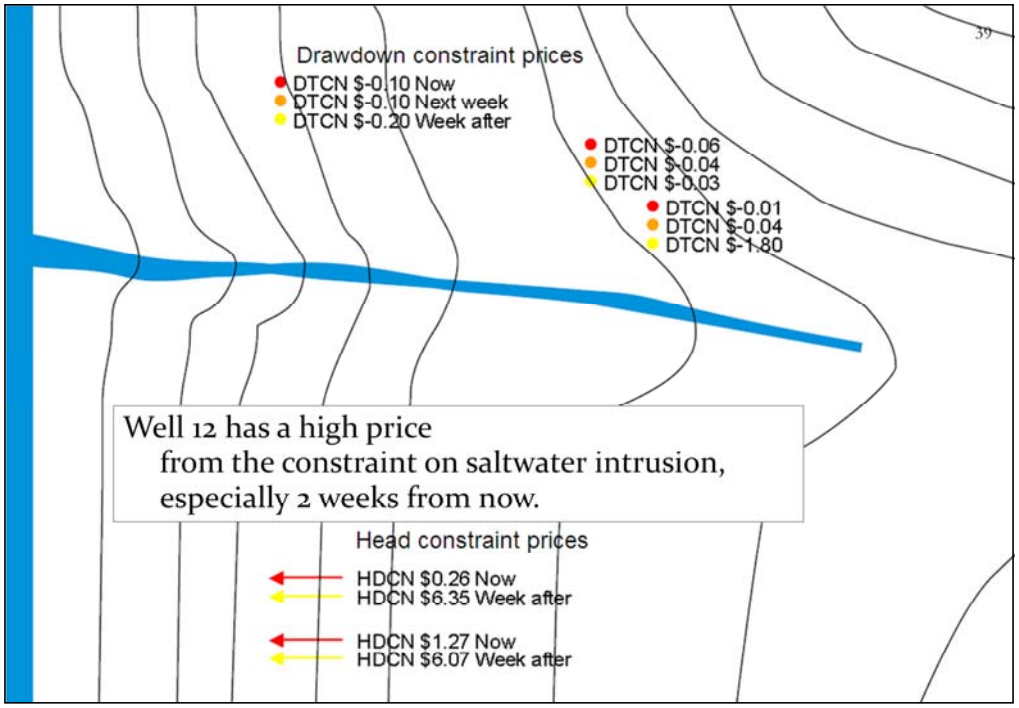
Why is Well 12's price so high? Well 12 has a high price because it is right next to the coast. The salt water intrusion constraint is "binding," meaning that no one should take more water near the coast, to avoid damaging the freshwater aquifer. Even if well 12 bid up the water to a billion dollars, the computer would not allow the salt water intrusion constraint to be violated.



我们假设每个人都有同等价值的水。如果价格超过5美元用户将出售所有的水。

在这个例子中，我们假设用户没有初始许可，而且他们必须向政府购（这些许可）。

为什么12号水井的价格如此之高？ 12号井具有较高的价格，因为它刚好在海岸的旁边。咸水入侵的制约因素具有“约束力”，这意味着任何人都不应在海岸附近取更多的水，以避免淡水含水层遭到损坏。即使12号水井的水价涨至10亿美元，电脑也不会让咸水入侵这个约束条件受到违背。

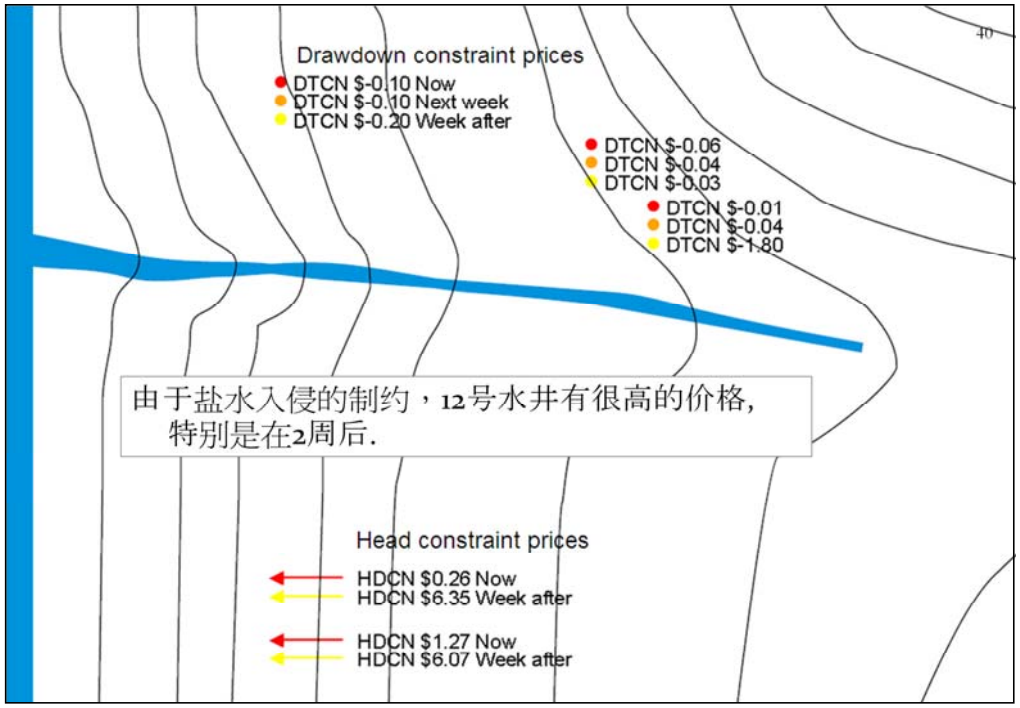


This shows the "shadow prices" of the constraints. Even though all users bid identically, the prices are not all equal, because the hydrology isn't uniform.

The DTCN labels show the aquifer drawdown prices.

The HDCN labels show the head difference constraints near the coast. Note that the "Week after" price is very high. What's happening is that the hydrological cone of abstraction will take about 3 weeks to hit the coast, so we need to discourage people from taking too much water now, to avoid future damage.

Not shown are some head difference constraints for the stream. These were omitted because the price is zero – the stream get more flow than required.

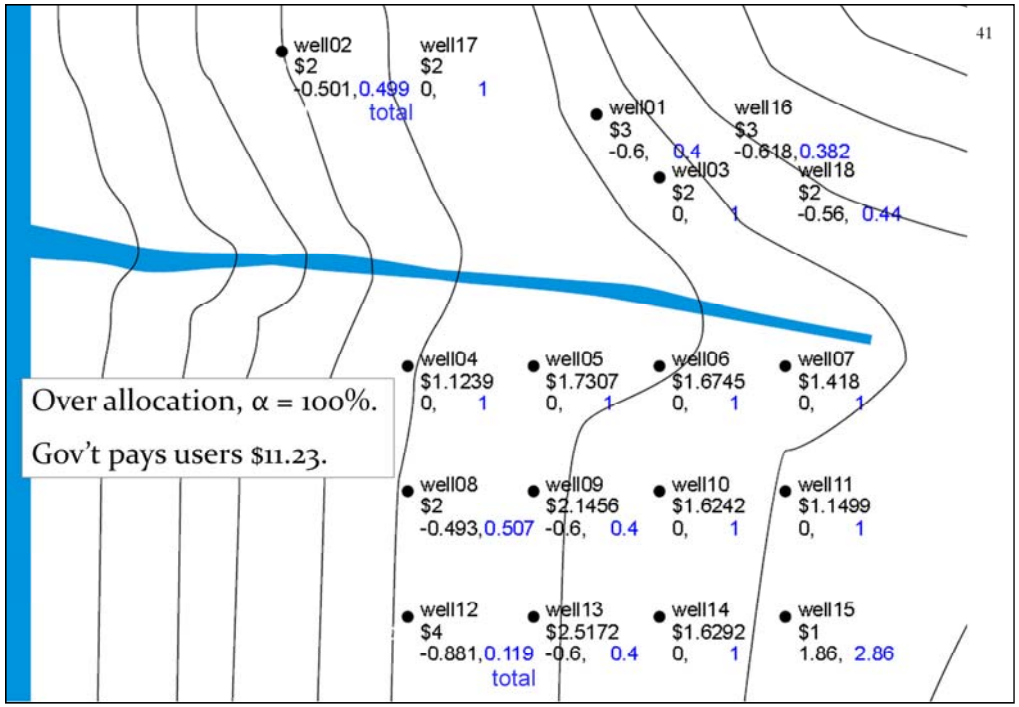


这表明了"影子价格"的约束。即使所有的用户出价相同，但价格并非都相等，因为水文条件并不一致。

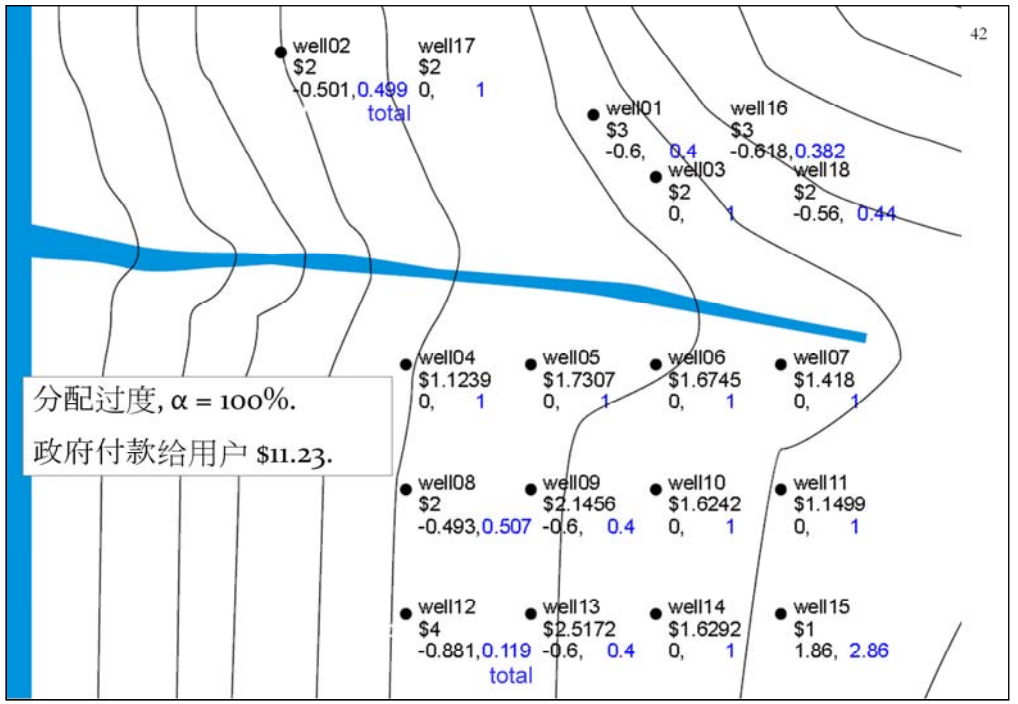
该DTCN标签表明了含水层会削减价格。

HDCN 标签显示了海岸附近的水位差的限制。请注意，"一周之后"的价格非常高。所发生的事情将是抽象水文锥需要约3个星期才能到达海边，所以我们现在需要阻止人们从取过多的水，以避免未来的损害。

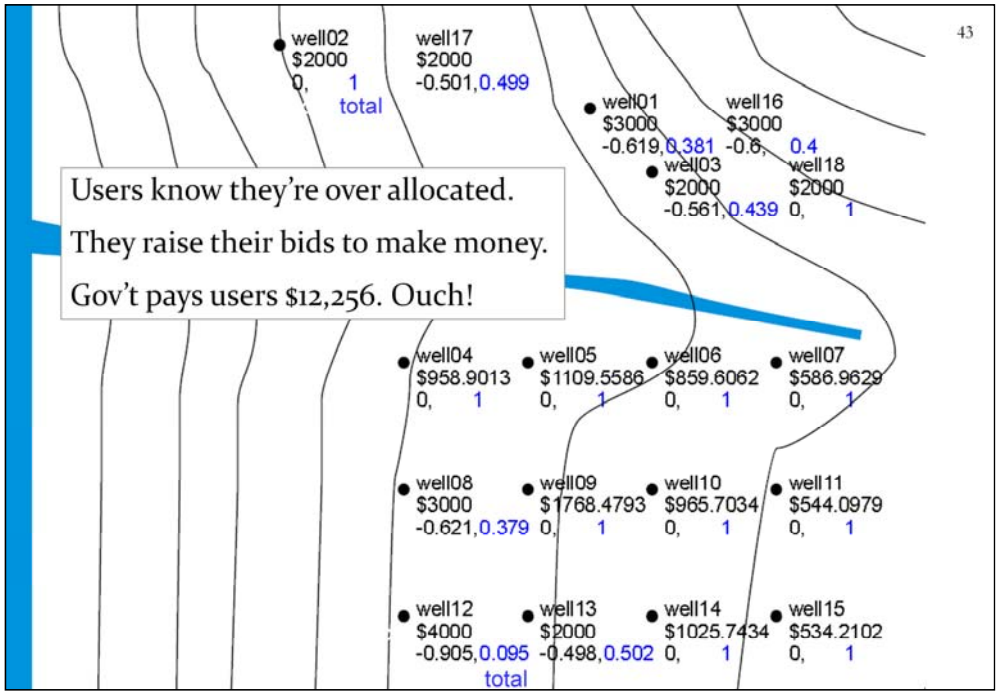
小溪的一些水位差的限制没有被显示。因为价格是零，所以这些被省略了- 这些溪流得到了超过所需要的流量。



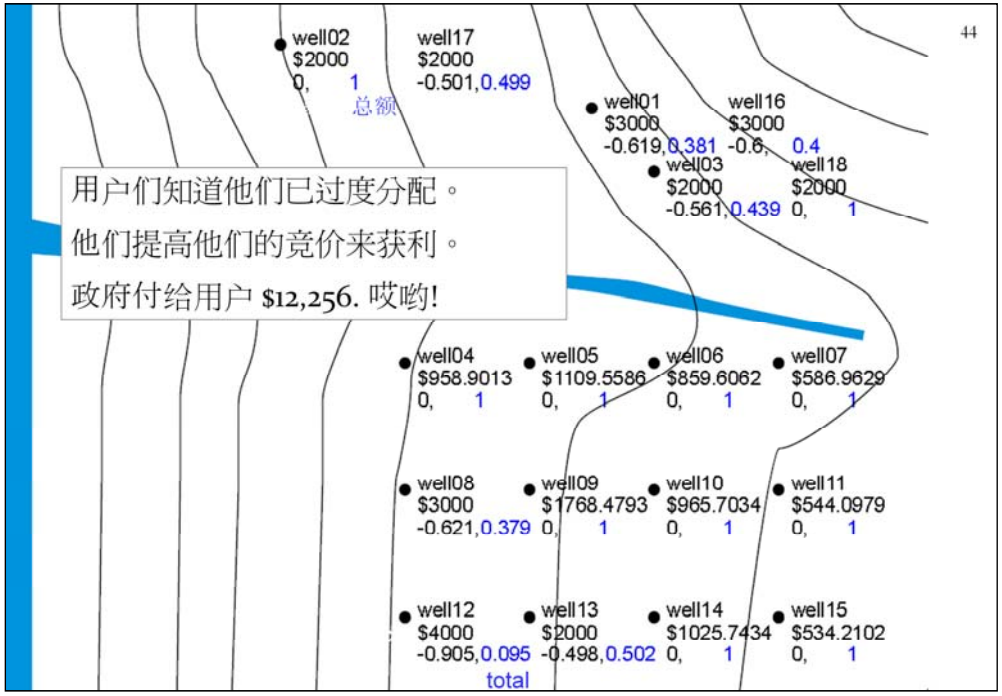
If we give users their full allocation, the computer still ensures that all environmental constraints are satisfied. The only way to achieve this is if government buys back consent from users. This is not very clever!



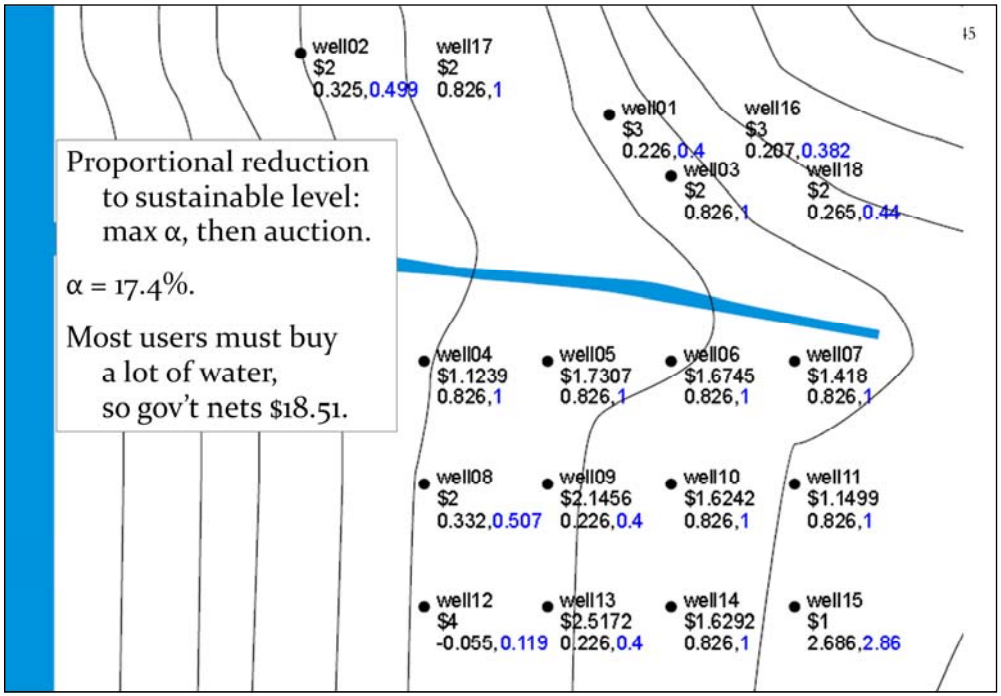
如果我们将所有分配全部给用户，计算机仍然可以确保所有的环境约束将被满足。唯一做到这一点的办法是政府从用户处回购许可。这不是很聪明！



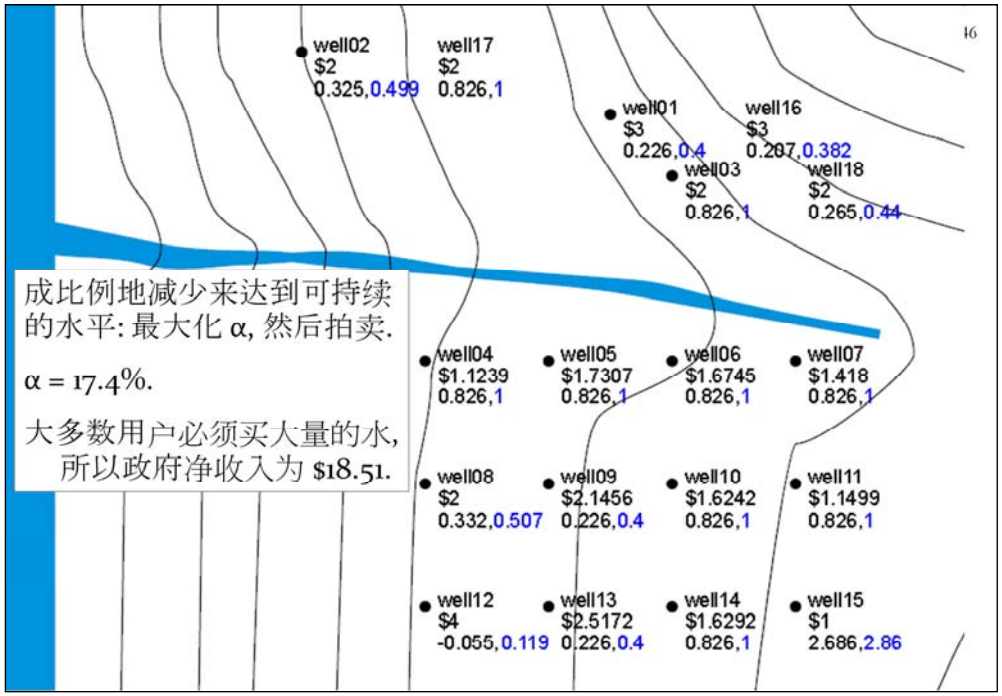
If users know that the catchment is over allocated, they will be tempted to hold government to ransom, and raise the price to infinity. And the computer, because the environmental flows are constrained, will force the government to pay it! Obviously, this is not a tenable situation.



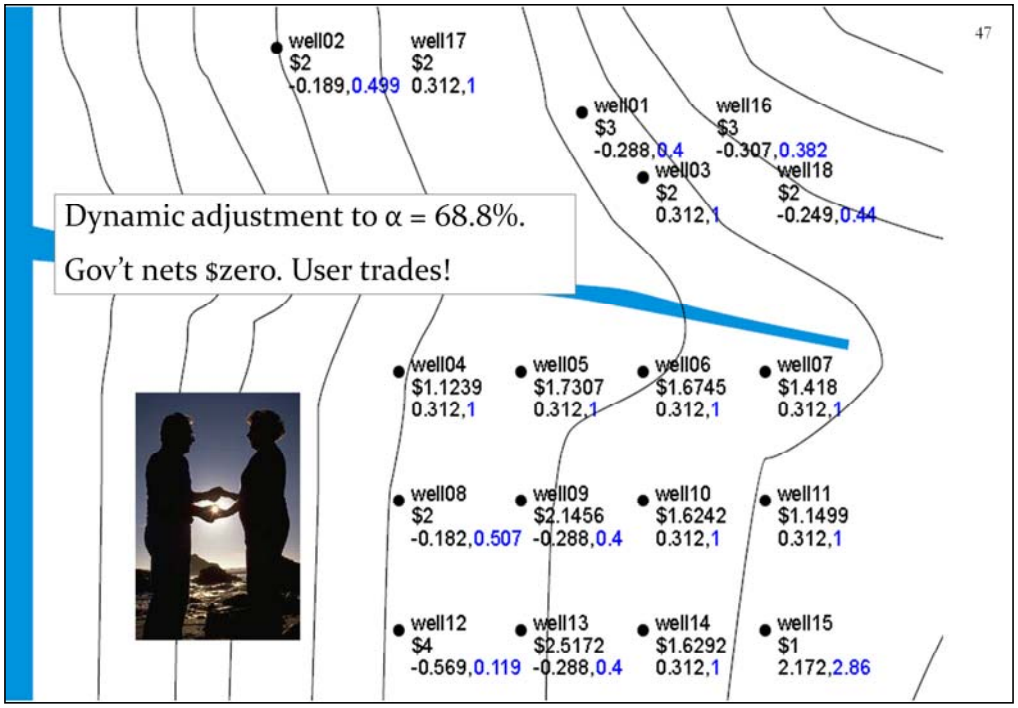
如果用户知道集水区分配过度，他们将会通过政府牟取赎金，并且将价格提高到无穷。并且计算机因为环保流量的约束将迫使政府支付！显然，这不是一个站得住脚的情况。



So government can maximize the proportion that *all* users can get sustainably. Unfortunately, that proportion is determined by the "driest" well, well 12, which is right on the coast. So we see that most users have their consents cut back, and then the users buy the rights again. They are likely to complain about that.



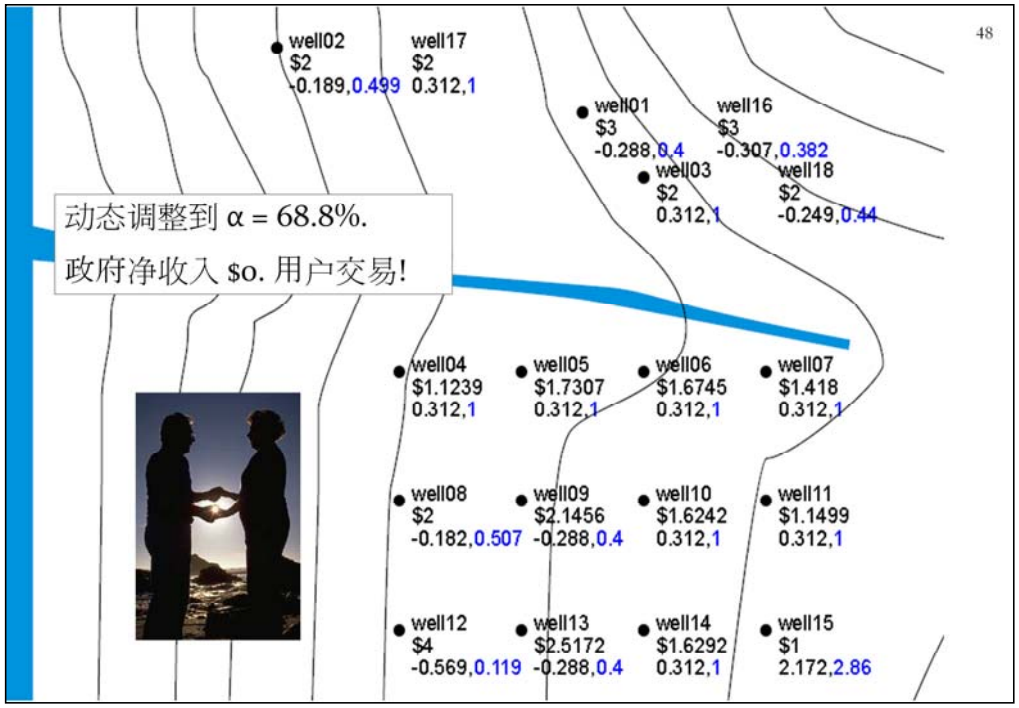
因此，政府可以最大化使所有用户都取得持续性的比例。不幸的是，这一比例取决于最"干燥"的井，12号水井，它最靠近海岸。因此，我们看到，大多数用户削减他们的许可，然后再购买取水权。他们很可能会对此抱怨。



Here, we have found a proportion where government nets $0. This is much higher than before. Now government has no net financial interest in the market, and serves as a impartial broker.

In fact, we have found even better ways to set this alpha parameter. In any case, this user trades scenario appears to be much more acceptable politically, and we think it gives users the correct incentives.

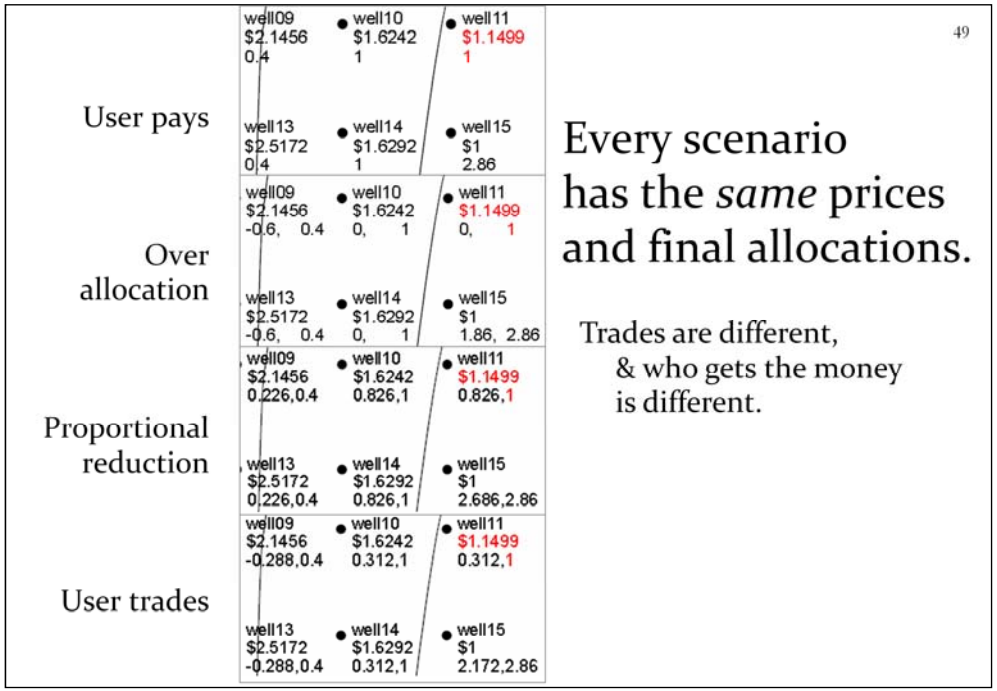
Government could adjust alpha slightly to cover the costs of running the auction. This is a water market with control.



在这里，我们找到了一个使政府净收入为0的比例。这个比例比以前高许多。现在，政府在市场上没有净经济利益，并且充当一个不偏不倚的中间人。

事实上，我们已经找到了更好的方法来设置 参数。在任何情况下，该用户贸易的情形似乎在政治上更可以被接受，而且我们认为它为用户提供正确的激励机制。

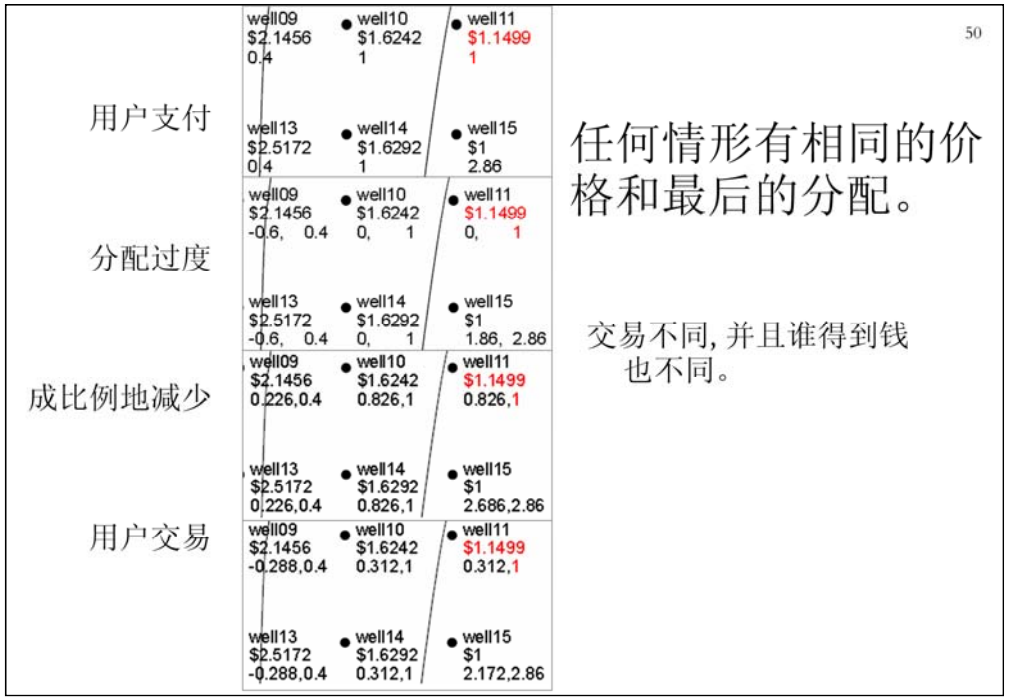
政府可以稍微调整　　支付拍卖运行成本。这是一个受控制的水市场。



Ronald Coase from the University of Chicago proved that this would happen: given sufficiently low transaction costs, and no budget effects, then initial rights are independent of the final optimal allocation. Unfortunately, without the smart market, allocating environmental resources has huge transaction costs.

The point is that, from an economic point of view, the initial rights won't affect the final allocation. But business people know that the initial rights strongly affects who gets the money! So users will press for large free initial rights, just as the carbon emitters are pressing for free credits.

Now let's look at some realistic cases.



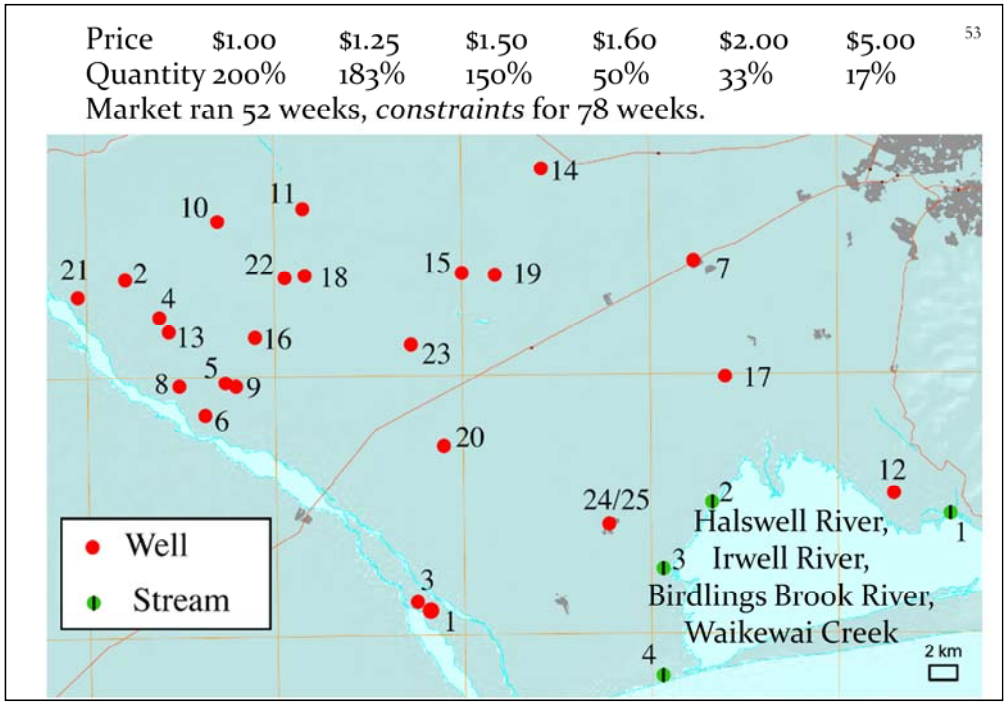
来自芝加哥大学的罗纳德科斯证明这种情况会发生：假设交易成本足够低，并且没有预算的影响，那么初始的权利不取决于最后的优化配置。不幸的是，没有这些智能市场，分配环境资源的交易成本十分庞大。

问题的关键是，从经济角度来看，初始权利不会影响最终的分配。但是，商界人士都知道，最初的权利强烈地影响谁将得到钱！因此，用户将争取大量免费的初始权利，正如碳排放者正在争取免费的许可一样。

现在让我们看看一些现实情况。

This work was done by an MBA student, Manfred Plagmann, and sponsored by Selwyn District Council. Our thanks to them for their support. The study area here is the farms around Lake Ellesmere. The concern is to ensure the flow of streams that flow into the lake.

这项工作由一个工商管理硕士学生- Manfred Plagmann 完成，由Selwyn区议会赞助。我们感谢他们的支持。该研究地区是埃尔斯米尔湖周围的农场。应当关注的是确保流入湖里的溪流流量。

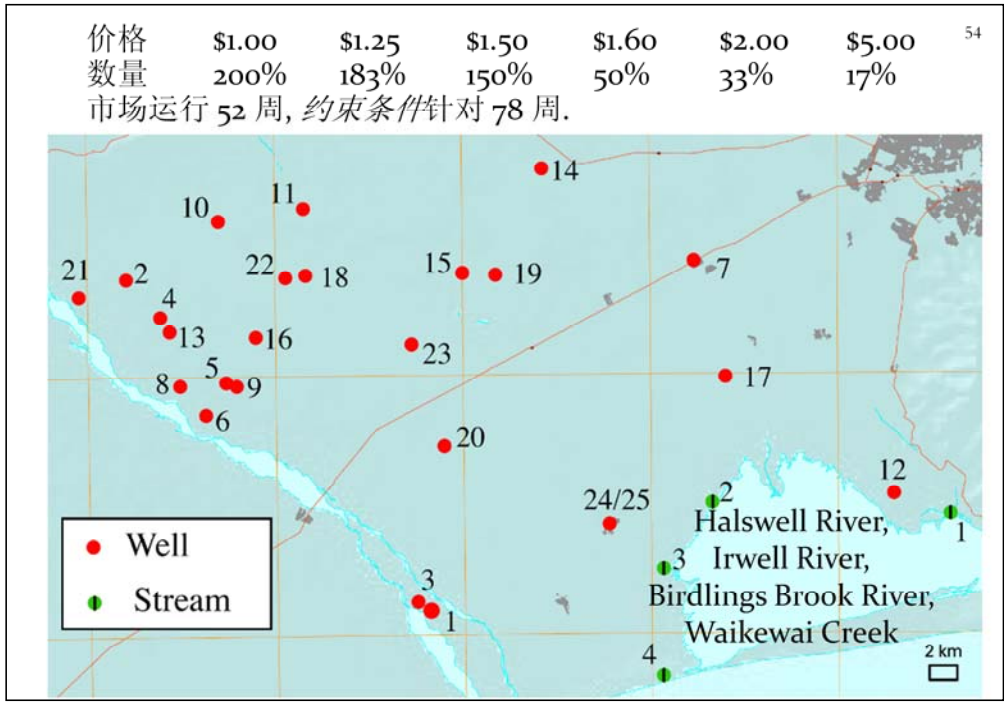


[Explain map]

For price ≤ $1/Ml, a user would buy a volume equal to his permit.

For more than $5/Ml, a user would sell all their permit.

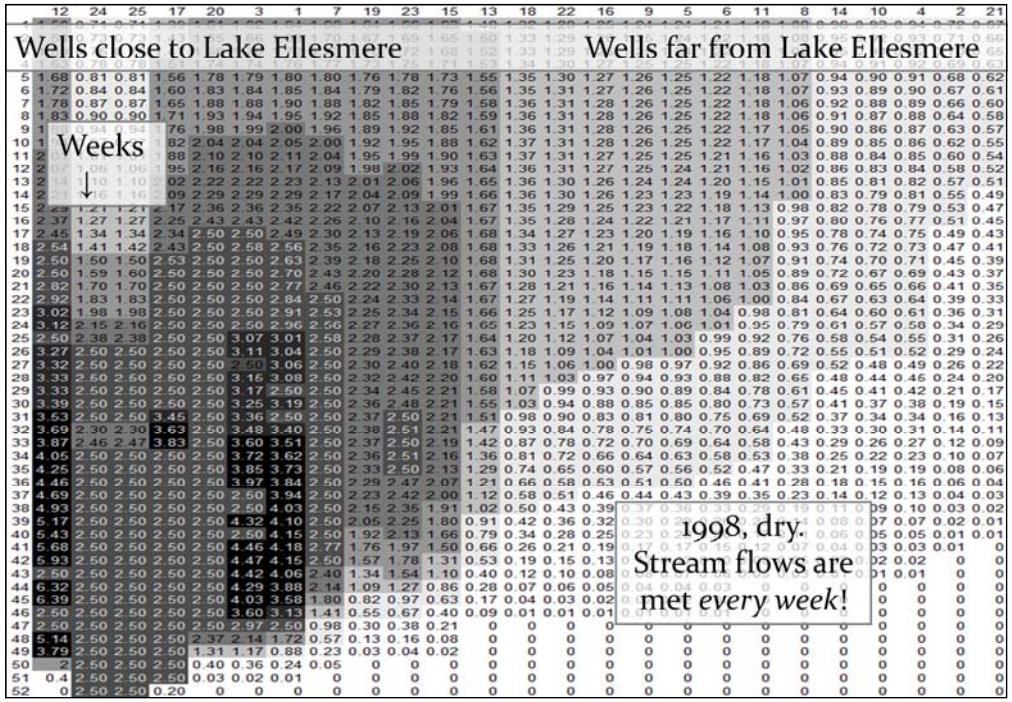
Market ran 52 weeks, but *constraints* ran for 78 weeks to ensure sustainability into the future.



[地图说明]

对于低于或等于$ 1/Ml的价格，用户的购买量将等于其许可量。
对于$5/Ml以上的价格，用户将出售其所有许可。

市场运行52周，但约束却针对78周以确保可持续到未来。



This is a simulation of a market in which we assume that all users would try to take water for the whole year. Instead of a one-period snapshot, we are looking at a schedule of prices over the course of a year. Each row is a week

Each column is one well, sorted from left to right by how close each well is to Lake Ellesmere. So well 12 is closest, and well 21 is furthest away.

The price is highest for wells close to Lake Ellesmere, and highest in the driest part of the year.

It is important to understand all flows for all four stream were guaranteed in every week of the year!

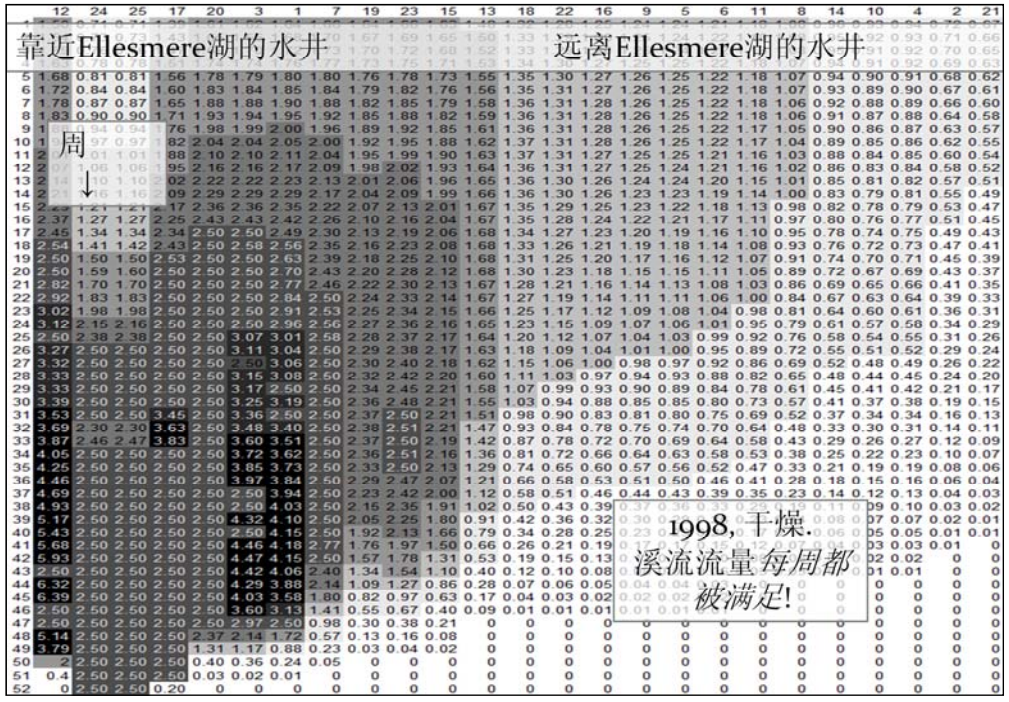
There's no way that anyone could guess these prices in advance! A flat water charge could never be set correctly over time and by location.

There's no way that pair-wise trading would have found this optimal solution. Free trade won't work, because the transaction costs are too high.

There's no way that any community-based committee could negotiate this – the streams would have gone dry before they'd made their decisions.

This will work, easily, if government facilitates trade with a central auction while protecting the commons with constraints.

A water market with control.



在这个模拟的市场中，我们假设所有用户将设法为一整年而取水。我们观察一年的价格表，而不是短暂的一瞥。每一行是一周。

每列是一口井，根据其离Ellesmere湖的距离，从左向右排序。则最接近湖的是12号水井，21号水井离湖最远。

接近 Ellesmere 湖的水井的价格最高，在一年内最干燥的时其候价格也最高。

要确保所有四条溪流在一年里每个星期的所有流量，了解这一点十分重要！

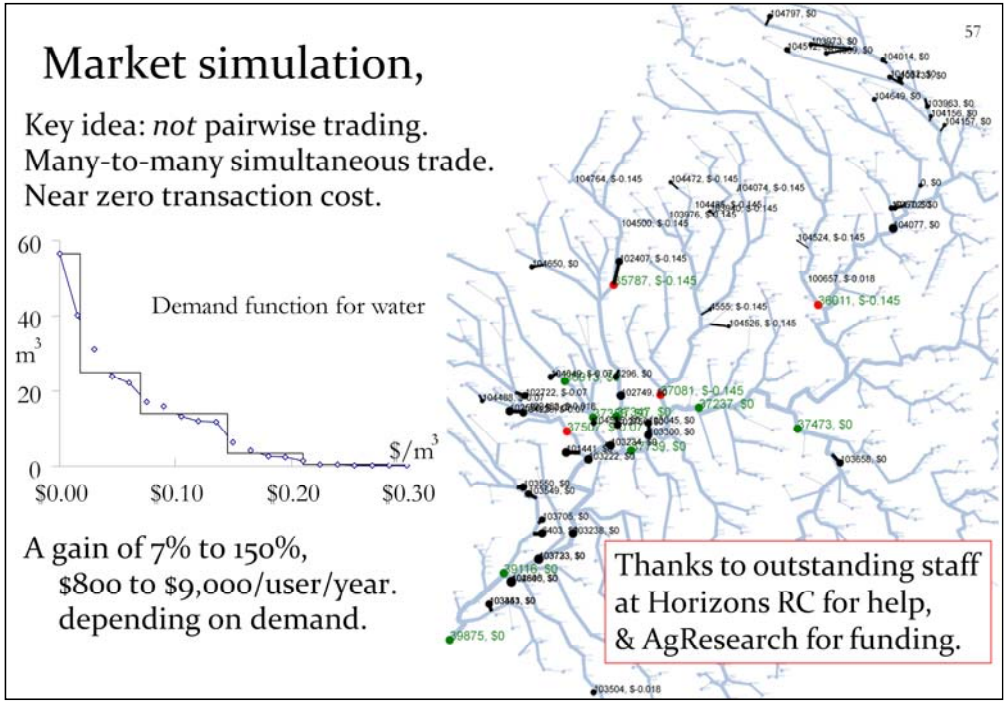
任何人都没有办法提前猜测这些价格！一个均衡的水费永远不能通过时间和地点而被正确地设置。

成对交易将无法找到最佳解决方案。自由贸易将因为交易成本太高而不能正常工作。

任何以社区为基础的委员会没有办法对此协商 – 在他们做出决定之前溪流可能已经干涸。

这将很容易地运行，前提是政府通过约束条件保护公共资源的同时，通过中央拍卖来促进交易。

一个受控制的水资源市场。



First let me say a big thank you to the excellent staff at Horizons Regional Council for their help in putting this case together, and to AgResearch for funding it.

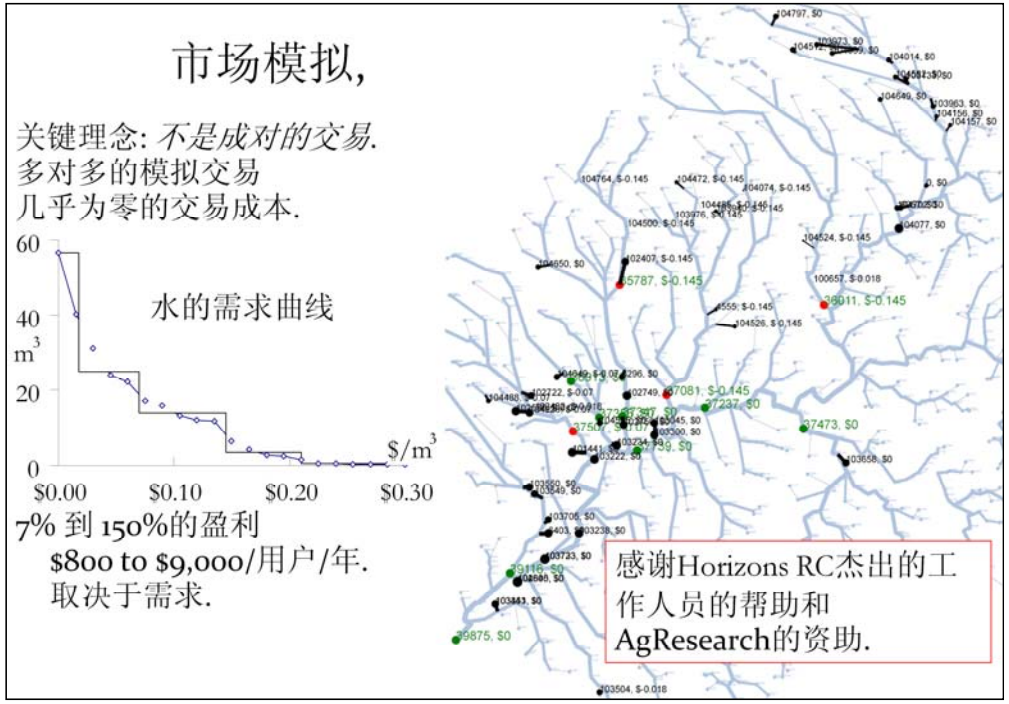
This case study is for surface water, not ground water, in Upper Manawatu. The operations research for this type of problem is very old and well studied.

Remember, there's no pairwise trading, but rather this is a many-to-many simultaneous trade, with transaction costs near zero.

I created a synthetic demand curve from public data sources. In a real market, prices would be set by your own value for water. I wasn't able to interview every farmer in Manawatu to get their private value for water!

The result was a gain of 7% to 150%, depending on what was assumed about growth in demand.

[follow slide]



首先让我对Horizons地方议会的出色职员说声感谢，感谢他们帮助我们整理这个案例，并感谢AgResearch所提供的资金支持。

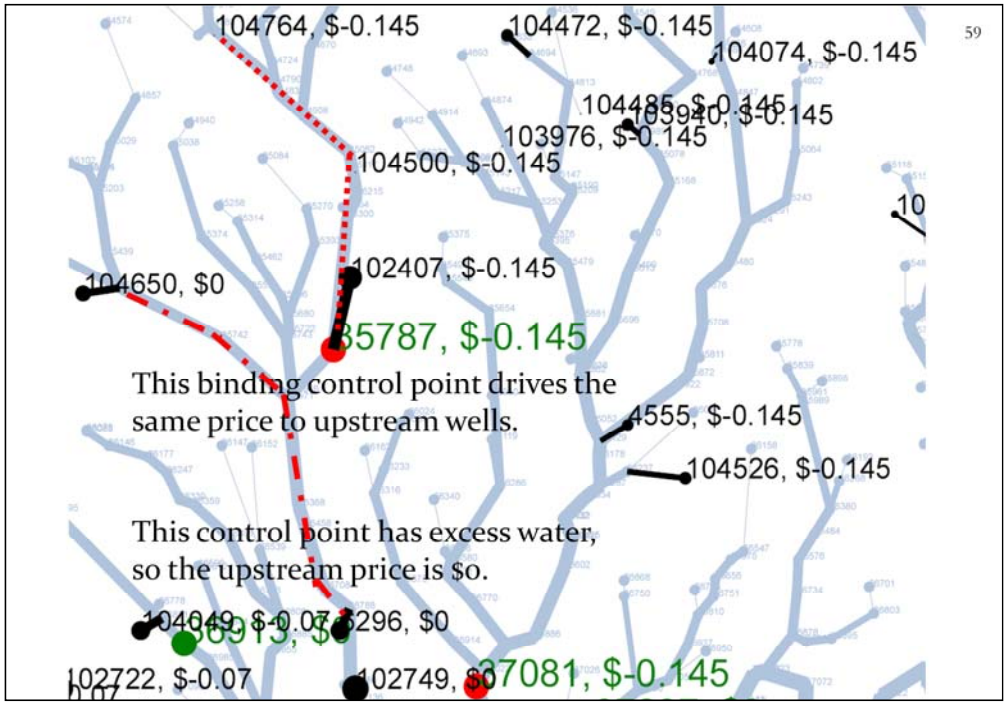
本案例研究是针对Upper Manawatu地表水的，而不是地下水。此类问题的运筹学研究非常古老并有很好的研究。

记住，没有成对交易，而是一个多对多的同时贸易，交易成本接近零。

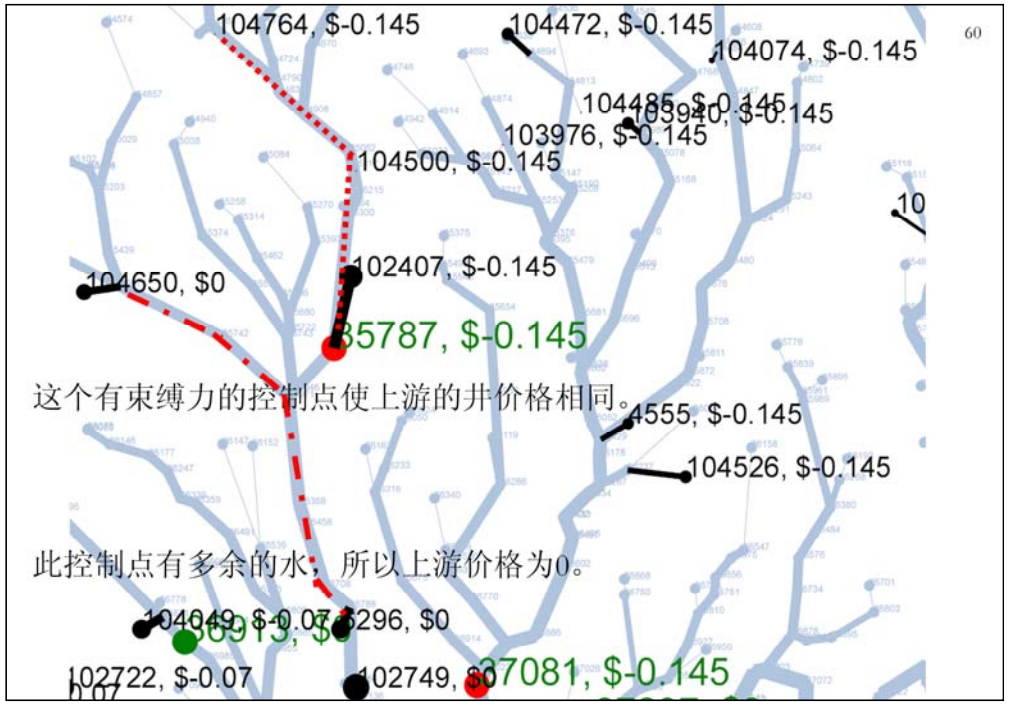
我从一个公共数据源创建了综合需求曲线。在一个真正的市场，价格由您自己对水的价值的评估来定。我没能采访Manawatu的每个农民来得到他们个人对水的价值的评估！

其结果是7%至150%的盈利，这取决于对需求增长的假设。

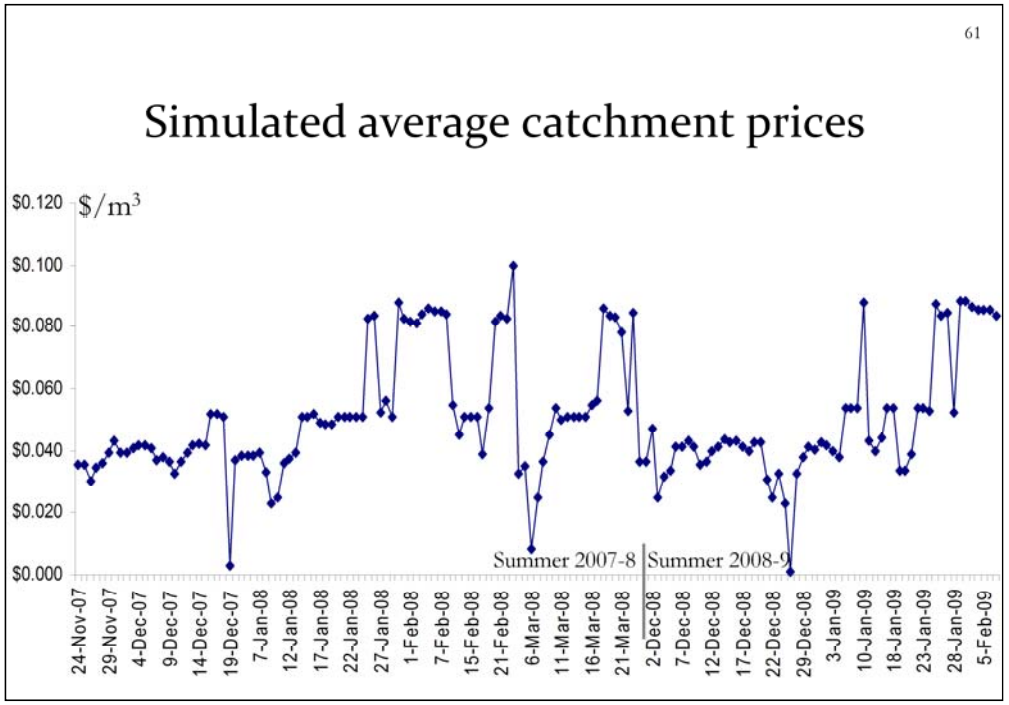
[后续幻灯]



Here, we see that prices upstream are driven by the control point down stream. For example, the price at control point 35787 is fourteen point five cents. The price at each well upstream is the same.



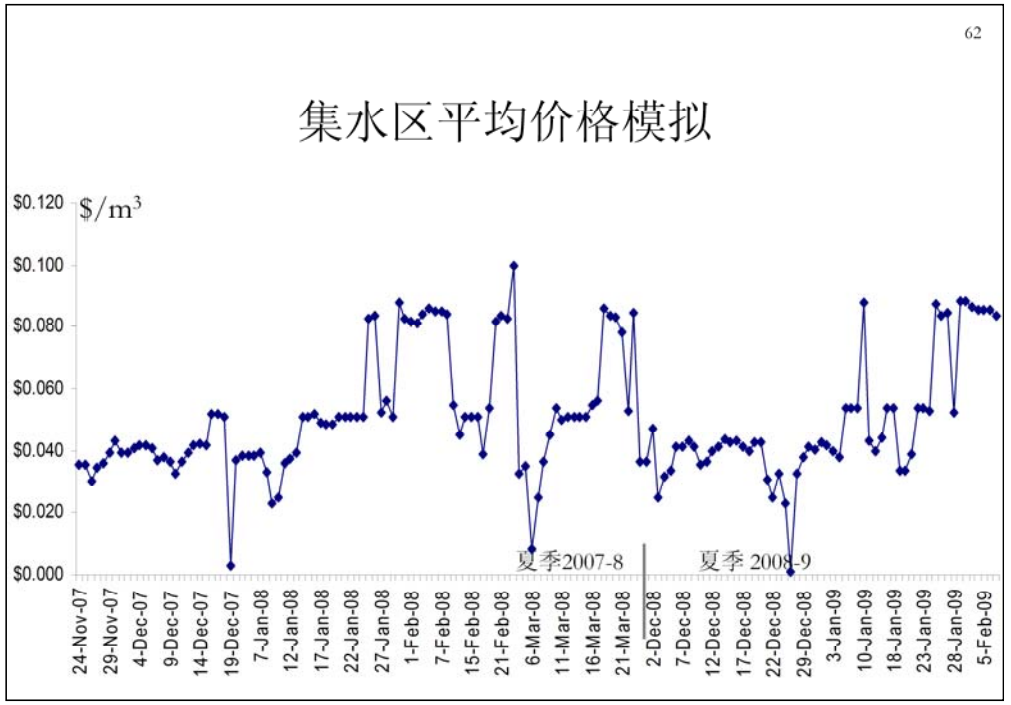
在这里我们看到，上游价格由下游控制点所驱动。例如，在控制点35787的价格是14点5美分。在上游每口井的价格相同。



This graph shows the simulated prices by day for two summers. Prices are determined by farmers and available rain. Note that these prices are the **shortage** cost: the lost farm profit per unit water.

Prices depend on daily rain, so this is a responsive allocation mechanism. It would be highly robust with immediate response to climate changes.

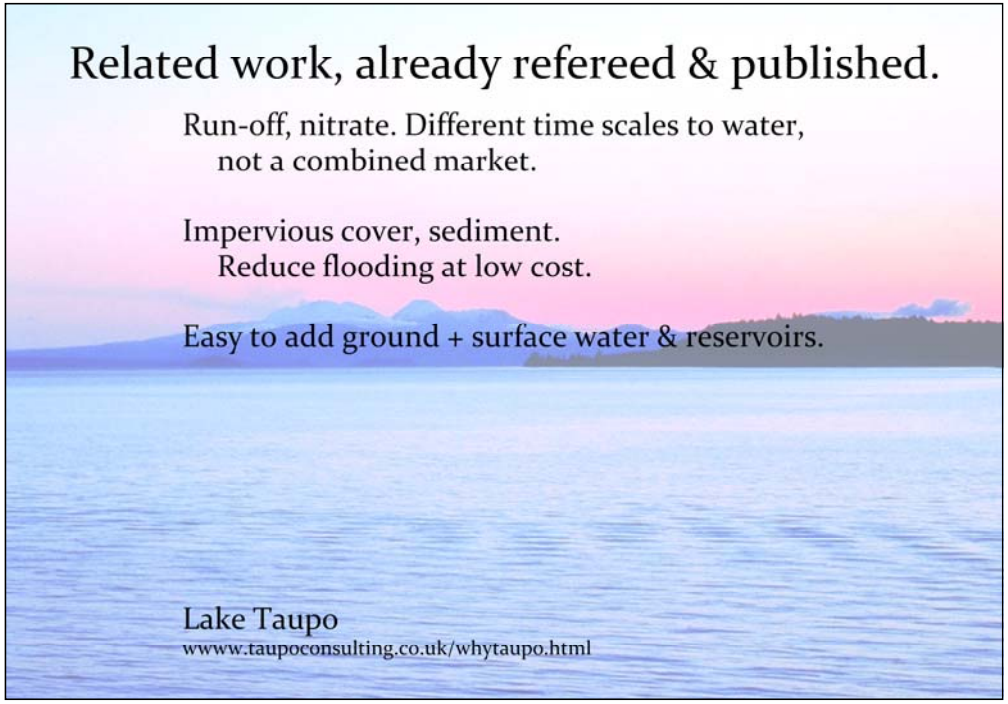
This price information would be valuable in planning any kind of water-related investment.



本图显示了两个夏季每天的模拟价格。价格由农民和现有雨量决定。请注意，这些价格是**短缺**成本：农场每单位水损失的利润。

价格取决于日降雨量，所以这是一个反应灵敏的分配机制。对气候变化的立即反应，这将能良好地工作。

此价格信息将对规划任何一种与水有关的投资都有价值。



Our work has been heavily refereed already, and much is now published in top journals. We've been at this a long time.

We've done additional work on run-off, especially nitrate, and we're looking at problems of impervious cover, especially to reduce flooding. Interestingly, in many cases, water quality will be a separate market to water quantity, because of the different time scales of their movement.

Our work on water markets for ground water easily generalizes to complex catchments, including surface water and reservoirs. In fact, ground water was the hard case.

We're working on writing open source software to run the auction models. Unlike the Apple iPad, I think our methods will still be used hundreds of years from now.

Lake Taupo, NZ, ww.taupoconsulting.co.uk/whytaupo.html

我们的研究已经被大量地引用，并且大部分已在顶级刊物上发表。我们从事这个项目已经持续很长时间了。

我们对径流，尤其是硝酸盐做了额外的研究，并且我们正在研究防渗覆盖问题，特别是减少洪涝。有趣的是，在许多情况下，水质将是一个独立于水量的市场，因为他们的运动有不同的时间尺度。

我们对地下水的市场研究将很容易地推广到复杂的集水区，包括地表水和水库。事实上，地下水是困难的研究对象。

我们正在研究开发公开来源的软件来运行拍卖模型。 与苹果公司的iPad不同的是，我认为我们的方法将在数百年内仍会被继续沿用。

Lake Taupo, NZ, ww.taupoconsulting.co.uk/whytaupo.html

Water agency runs a constrained auction for big commercial users to lease consent.

1. Metering, hydrology data, environmental limits.
2. Set initial rights. Manager must adjust initial rights to conditions.
3. Write web page, hold auction, run model, report results.

End. Thanks for coming! Email any questions, I'll answer. Godwits in flight

www.teara.govt.nz/en/bird-migration/1/1?setlang=mi

Connect a hydrological simulation to a constrained math model, to the internet.

Reduce costs for business *and* enable business in aggregate to act sustainably.

Users must be metered, preferably telemetered. Start with the largest users who would have the most to gain, and who have the largest impacts.

Get impact coefficients. Often, already available! Choose env. limits.

✓ Set initial rights. Just grandfather in existing consents. The auction manager must have authority to adjust initial rights to conditions, but the water agency already has this authority.

Write web page, announce auction, run the model, report the results. Enforce the law.

✓ So we are proposing a water market with control. The Forever Fair water market system would move water to the highest value use, incentivize efficiency, guarantee the environmental flows, and make governance far easier. Implemenation cost would be cheap, maybe about the same as the feasibility study for a new reservoir.

Do you want a better environment *and* more money for business? Do you want to use a scientific approach? If so, call me!

水务机构管理有约束的拍卖来使大商业用户出租许可.

1.计量，水文数据，环境的限制。
2.设置初始的权利。经理必须根据条件来调整初始权利。
3.设计网页，举行拍卖会，运行模拟，报告结果。

饮水思源. Remember the source!

结束. 感谢您的参与! 如有任何问题，请给我写电子邮件，我将回答您的问题.

飞翔中的信天鸽

对一个约束数学模型进行水文模拟，并连接到互联网上。

www.teara.govt.nz/en/bird-migration/1/1?setlang=m

降低业务成本，使业务在总体上持续发展。

用户必须按表交费，最好是远程计量。从最大的受益用户和有最大影响力的用户开始。

获取影响系数。通常情况下，已经存在！选择环境限制。

✓设置初始的权利。对现有许可沿用旧方式。拍卖会经理必须获得授权并根据条件调整初始权利，但水务机构已经具备这样的权力。

设计网页，公布拍卖，运行模拟，报告结果。执法。

✓因此，我们提出一个受控制的水市场。这个永远公平的水市场制度将水的使用调整到最高价值，提高效率，保证环境流量，使管理更加容易。实施成本将会降低，可能和新水库的可行性研究的成本基本相同。

你想拥有一个更好的环境和更盈利的商业？你想使用科学的方法？如果是，请与我联系！

A very big thankyou to Yu Ye for translating!